THE ILLUMINATING ENGINEER

LIGHT LAMPS FITTINGS AND ILLUMINATION

THE JOURNAL OF GOOD LIGHTING

Official Organ of the Illuminating Engineering Society

FOUNDED IN LONDON 1908

Edited by LEON GASTER

. OIL . GAS ELECTRICITY ACETYLENE PETROL-AIR GAS ETC.

Vol. XVIII June, 1925 Price NINEPENCE

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For Foreign Countries, 15/- per annum.

## Special Features:

The I.M.E.A. Convention—Street Lighting—Lighting Conditions in 800 Retail Shops (Discussion)—Lectures on Illuminating Engineering—Lighting at the British Empire Exhibition—Notes on Electric Lamps—News from Abroad—Reviews of Books, etc.

*See Page III of Cover*

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# The I.M.E.A. Convention

## Public Service and Public Lighting

THE I.M.E.A. Convention at Brighton during June 15th to 20th, which the writer had the pleasure of visiting, was as usual well attended, upwards of 850 members and delegates being present. The President on this occasion, Mr. W. C. Tapper was for some time closely associated with Mr. Arthur Wright, who presided over the very first Convention of the I.M.E.A. held at Brighton. One recognized in Mr. Tapper's opening address the enterprise and sagacity characteristic of his work. He recalled that the number of units sold by municipal undertakings had risen from about 30 millions in 1895-6 to nearly 3,000 millions. Capital expenditure similarly has increased from four to over 150 millions. This is a substantial advance, but Mr. Tapper predicted that developments during the next 30 years will be on an even greater scale.

But the various papers revealed a recognition that, despite this advance in the generation of electricity, further steps are necessary to secure its proper application; to make known to the public the benefits of electricity in general and good lighting in particular. Mr. Thickett answered the query, "Are supply undertakings doing their utmost to develop the demand for electricity?" in the negative. It is admitted that electricity undertakings suffer under drawbacks, and that existing legislation makes it difficult for them to render as good a public service as they desire by advising consumers on their installations, carrying out wiring schemes, etc., and generally aiding the consumers in the manner pursued by electrical undertakings in other countries and by progressive gas undertakings in this country. Mr. L. L. Robinson, one of the most active of Central Station engineers, in his paper on installation policy, discussed another aspect of this question—the part to be played by electrical contractors. That the leading contractors do good service is generally recognized. We share Mr. Robinson's belief that contractors of standing should not suffer by the proposed changes enabling supply undertakings to render service, but should ultimately benefit by the greatly increased demand for electricity, which a proper publicity campaign would ensure.

Much of the discussion turned on the question of publicity, and a tribute was paid to the excellent work done by Mr. Beauchamp and his associates on the E.D.A. There can be no doubt that with fuller support this work could be greatly extended, with benefit to the electrical industry. We would also like to suggest that, by working in closer relations with the Illuminating Engineering Society, both gas and electrical undertakings could benefit from an existing organization for bringing home the benefits of good illumination.

An interesting paper on street lighting (summarized on page 154 in this issue) was read by Mr. Haydn T. Harrison, who quoted Mr. Preston Millar to the effect that all objects of satisfactory street lighting can be served when appropriations are adequate. The natural question is, "When are appropriations adequate?" The data collected by Mr. Harrison throws interesting light on this point. He found that the average rate allotted to public lighting is 5·3d., and that this represented 3·36 per cent. of the total rates levied—certainly not a high proportion to pay for an important service such as public lighting. The lowest rate recorded was 1½d., in an area which is considered to be well illuminated. There is every reason to think that the public, if the importance of good street lighting was put before them, would wish that a somewhat larger proportion of the rates should be expended on a service from which they obtain such direct benefit, and in which they should take a legitimate pride.

In the discussion the importance of good public lighting was accepted, and the need for publicity in this field was emphasized. As the writer took occasion to point out, municipal and electrical engineers are well aware of the benefits of good public lighting; the problem is to bring this point home to street lighting committees and others with whom the allocation of money for public lighting rests. They, in turn, are the servants of the public, so that progress depends mainly on education of ratepayers. Street lighting has many aspects which did not arise in the days of relatively slow traffic. It is now of paramount importance in the interests of safety and for the prevention of street accidents. The headlight problem is closely associated with the provision of adequate public lighting. New arterial roads are now under construction, and cannot effectually serve their purpose unless they receive illumination suitable for the traffic they are to carry.

The problem of street lighting is thus a many-sided one, and we believe that the Illuminating Engineering Society, which acts as the guardian of public interests in matters of illumination, can aid the I.M.E.A. considerably in their efforts to bring about improvements, and closer co-operation is much to be desired.

## A New Criterion of Street Lighting Excellence

IN view of the above remarks on street lighting, Mr. L. B. W. Jolley's comprehensive article in the present issue (pages 155-160) deserves special notice. There are many different factors which contribute to the "excellence of street lighting," such as distribution of light, spacing of lamps, etc., which are considered by the author in turn. In particular, the choice between symmetrical and "asymmetric" units (concentrating light longitudinally) requires consideration. There has recently been much discussion on the proportion of the total light to be concentrated on the actual roadway, as compared with that allotted for the illumination of surfaces of buildings, etc.

Another point that has often been emphasized is the desirability of providing sufficient illumination in a vertical plane. It has been urged that in connection with street traffic we are concerned mainly with the illumination of vertical surfaces, such as sides of vehicles. But it is pointed out by Mr. Jolley that provided the minimum horizontal illumination midway between lamps is adequate one may, in practice, rely on the corresponding vertical illumination being considerably higher. This consideration, therefore, tends to support the view that the minimum horizontal illumination between lamps furnishes one of the best indications of sufficiency of light in a street, though naturally other factors, such as avoidance of glare and excessive contrasts, have to be taken into account.

## Progress in the Gas Industry

THE seventh annual meeting of the National Gas Council, which was followed by luncheon at the Hotel Great Central, on May 26th, was an impressive function, and there was much of interest in the address delivered by Mr. D. Milne Watson on this occasion. One notes, for instance, that in 1902 the sales of gas in Great Britain amounted to 160,000 million feet, that they had risen to 274,000 million in 1923, whilst 1924 is expected to show yet a further increase. Mr. Milne Watson paid a tribute to the valuable propaganda work of the B.C.G.A. in making the public familiar with the manifold applications of gas. He also alluded to the services rendered by the gas industry in acting as a conservator of coal, by extracting all its useful elements in the most efficient way. Supplementary data were given in the presidential address to the Institution of Gas Engineers, delivered on June 9th by Mr. Ferguson Bell, who drew attention to the continually increasing number of consumers and the steady growth of capital absorbed in the gas industry.

Both speakers devoted a great part of their addresses to a question that is exciting much discussion at the present time—the possibility that State assistance may be given to the new schemes for consolidating electrical supply and generation in bulk. Mr. Milne Watson, whilst expressing his disapproval of this principle, spoke with some sympathy of the work of electrical engineers. He agreed that electricity fulfilled most useful functions, and that, thanks to the skill and energy of those engaged in the industry, these functions are most admirably performed. Many gas undertakings, he remarked, themselves use electricity in their works. But he dissented from the impression that, through the more efficient use of electricity, vast savings in fuel, sufficient to justify State support, might be anticipated.

The question whether State aid should be rendered to electrical enterprise is somewhat outside our sphere. The question is a very debatable one, and even amongst the electrical industry there are differences of opinion. But we think that every impartial observer will agree that by some means the present chaotic conditions in regard to electrical supply should be simplified, and that conditions more resembling those in the gas industry should be introduced. One sympathizes for instance with the view that electrical undertakings should be empowered to give service to their consumers in the same effective and enterprising way as the leading gas companies do.

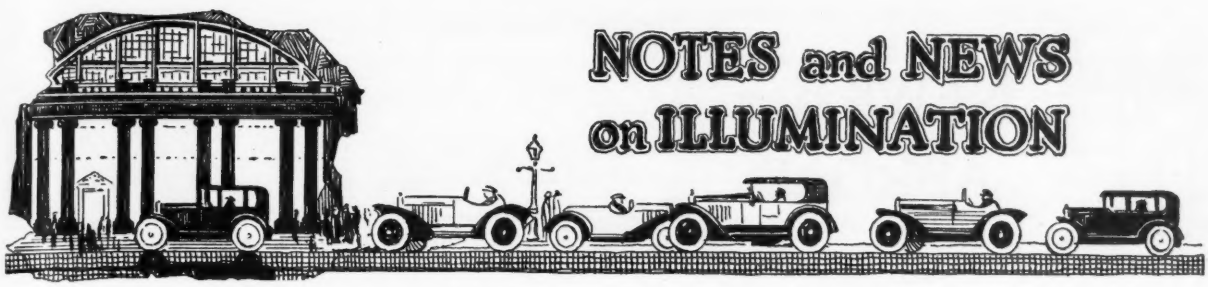
In desiring further development in the electrical field we do not admit for a moment that these advances must be made at the expense of gas. The figures quoted above to illustrate advances in the gas industry could be paralleled by similar data in regard to consumption of electricity. Both industries must advance together. It is our hope that in course of time they will become more closely allied than at present. Meantime we hope that any Government action contemplated in regard to electrical developments will be fully considered in all its aspects, that an opportunity will be afforded for hearing the views of all concerned, including representatives of the general public, and of avoiding any measures which might impede closer relations between these two great industries, both firmly established and deserving encouragement.

## The Lighting of H.M. Ships

IT is now rather more than four years since a paper dealing with various aspects of ship lighting was read by Mr. W. J. Jones before the Illuminating Engineering Society, on April 26th, 1921. Several engineers associated with the Admiralty took part in this discussion, and some interesting points in connection with the lighting of warships were raised. In an Admiralty Order dated August 10th, 1921, a few months after this discussion, a small committee was appointed for the purpose of "investigating the electric lighting of H.M. ships and establishments," and the Committee has now issued a compact handbook in which much useful information is given. The fundamental principles of good illumination are stated and, after the chief terms used in illuminating engineering have been defined, there is a very practical series of recommendations on ship lighting.

It is quite impossible to deal with these points *in extenso*. But we may note that throughout the authors lay stress on the avoidance of unshaded lights. The requirement that "no naked light shall be visible within an angle made by two lines from the eye, one being horizontal, the other at 40 degrees to the vertical" is somewhat more severe than that proposed by the Home Office Committee for factories. But in view of the confined space on board ships it is best to be on the safe side. In prescribing illumination for various purposes a distinction is drawn between average and minimum values, the former being in general either 3-5 or 4-6 foot-candles, and the latter, for most purposes, 1·5. Some recommendations are useful in suggesting what forms of shades should *not* be used. Thus crinkled and clear glass, which do not adequately screen lights, and frosted and sandblasted glass, which retain dust, are not recommended. Special problems on board ship are the lighting of gauges and dials of instruments, the illumination of hatches and dangerous places, and the selection of positions for lamps on the upper deck.

Altogether this series of practical hints, arranged in a most readable form, marks a distinct advance in procedure and the carrying out of these recommendations would do a great deal to ensure that H.M. ships are better lighted than in the past.




## Artificial Sunlight in Health and Disease

The discussion opened by Dr. C. W. Saleeby (Chairman of the Sunlight League) at the joint meeting arranged by the Illuminating Engineering Society on the 9th inst., proved most interesting. The close relation between sunlight and health is now generally recognized, and much useful information on this subject has been acquired during recent years. This is a good instance of a question that demands concerted effort. It is closely linked with the problem of smoke abatement, which is of great moment both to the gas and electrical industries; and with access of daylight into buildings, which is an important consideration to the architect. These various viewpoints were well expressed in the discussion, which was followed by a display of modern types of lamps for producing "artificial daylight" and ultra-violet rays, now widely used in the treatment of disease. We shall be reproducing the paper and discussion in our next issue, and the problem will then be discussed in fuller detail.

## Visit to Drury Lane Theatre

There are few problems more fascinating than the use of artificial light on the stage, and the visit to Drury Lane, arranged for the benefit of members of the Illuminating Engineering Society, by the courtesy of Sir Alfred Butt, on June 23rd, should prove of great interest. By kind invitation of the General Electric Co., Ltd., the visit will be followed by a discussion on stage lighting at Magnet House. We are unable to include an account of the proceedings before going to press with this issue, but the matter will be dealt with in our next number.

## Lectures on Illuminating Engineering in the United States

The recent announcement that the Polytechnic (Regent Street), where the course of special lectures on illuminating engineering has just been concluded, is now arranging a permanent course on this subject leads us to refer to two similar projects in the United States. The first of these is the series of talks on various aspects of illumination to be given by experts to the students of Cornell University early in 1926. The second is the course in illumination established at the University of Southern California, which starts next February. This course is arranged in co-operation with the local section of the Illuminating Engineering Society in the United States, which, like the Society in this country, takes every opportunity of showing its keen interest in education in illuminating engineering.

## Luminous Stockings

We notice that at the Drapery Exhibition at the Agricultural Hall a novelty in stockings was on view. By daylight they appear to be ornamented with green clocks and yellow flowers, but at night the designs appear luminous, as they are painted in phosphorescent material. The mixture used is stated to be a secret, but the use of such luminous compounds has been illustrated and discussed at several meetings of the Illuminating Engineering Society in recent years.

## Industrial Processes and Vision

It is commonly said that some occupations are more trying to the eyes than others, and therefore require exceptionally good illumination. In this connection the question arises, "For what percentage of time does a worker actually use his eyes in doing his work?" According to a recent note in the *Electrical World* some researches on this point have recently been made in the United States. In twenty industrial and office processes examined the average proportion of time during which the eyes of the operator are engaged in close work was found to be 70 per cent. In five cases the percentage was even higher. In only six out of the twenty processes did the proportion fall below 50 per cent., and in only three cases below 40 per cent. It seems, therefore, that in most representative office and industrial processes the eye is kept pretty constantly occupied, and inadequate lighting conditions are almost certain to have a prejudicial effect on production.

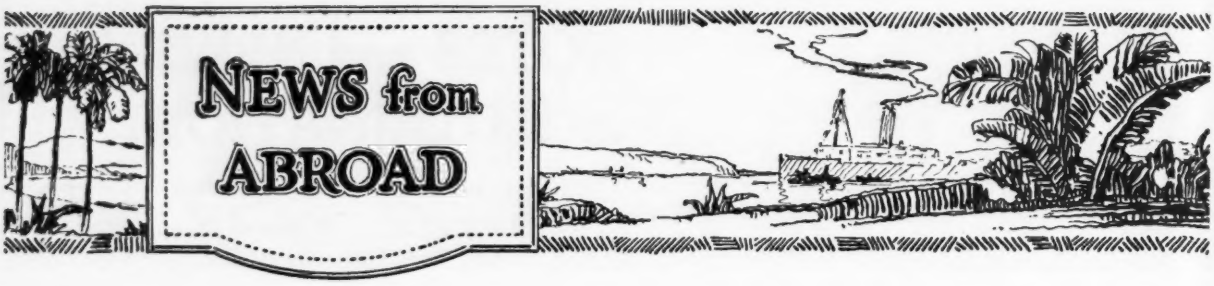
## Safety First Methods in the Kodak Works

In the current issue of *Safety First*, the official organ of the National "Safety First" Association, Mr. T. Sexton gives an account of the methods adopted to promote safety of workers in the Wealdstone Works of Kodak, Ltd. Total casualties have diminished from 42 in 1920-21 to 18 in 1923-24. Apart from ordinary measures of safety a special problem is introduced by the fact that much of the work is carried out in rooms illuminated by dull red light. Hence stress is laid on keeping gangways perfectly clear, as, in coming from a bright light into a dark room the range of vision is much reduced, and accidents may result. Any broken glass or cracked vessels are immediately destroyed. Their presence in a dark room is liable to lead to accidents. A cracked vessel may suddenly break while it is being used, the crack not being clearly visible. Attention is also drawn to the necessity for keeping exterior lights round the factory in good order, especially when night-shifts are employed.

## The Largest Tunnel in the World

The scheme for the driving of a new tunnel for vehicular traffic under the Mersey between Liverpool and Birkenhead now seems to be taking shape. It is believed that the new tunnel, which it is estimated will cost about £5,000,000, will be amongst the largest in the world. It is understood that the plans involve the division of the tunnel (44 ft. in diameter) into two sections, enabling four lines of traffic to pass above, and two lines below. The lighting of this large tunnel should therefore present special problems, and in this connection the information given regarding the methods to be proposed for the new tunnel under the Hudson River in the United States* deserve consideration. It will be recalled that the main feature of the proposed method of lighting the Hudson tunnel is the use of lamps at the sides of the tunnel, placed behind panels of diffusing glass. This allows a clear view in front for drivers, and is stated to be very successful in eliminating glare.

* *Illuminating Engineer*, April, 1925, p. 108.




## Demonstrations of the Benefits of Good Illumination

Much attention has recently been devoted to demonstrations of good and bad lighting and other methods of propaganda in favour of better illumination. The establishment of the E.L.M.A. Lighting Service Bureau in London was a noteworthy step, and it is understood that similar demonstrations are being arranged in other cities (including Newcastle and Glasgow). The idea is also a familiar one in the United States. It is very interesting to observe that it is now being adopted on the Continent. Thus a demonstration room has been equipped in the rue la Boëtie, Paris, by Mr. H. Maisonneuve, Director of the Service d'Eclairage of the Cie. des Lampes. A special demonstration was arranged at Spezia, Italy, last September. The equipment used in this demonstration has now been transferred to the main office building of the Clerici Edison Co. in Milan. The Osram Lamp Co., of Berlin, have made a special feature of their "Lichthaus," recently mentioned in this journal, which is under the direction of Dr. Rosenthal. The latest addition to these demonstration rooms is that made by the Watt Co., of Vienna, opened in the presence of the President of the Austrian Republic on March 6th. These facts, which were commented on in a recent issue of the transactions of the Illuminating Engineering Society in the United States, illustrate how the illuminating engineering movement is growing, and it is stated that plans for similar projects are under way in other cities, including Brussels and Budapest.

## A New Epoch in Illumination

Professor J. Teichmüller adopted the above title for a recent address before the Illuminating Engineering Society in Austria. With a good deal of insight he distinguished between three distinct stages in illuminating engineering. The first stage was occupied by attempts to secure higher efficiency in illuminants, which in Germany was well illustrated in Dr. Lummer's work, "Ziele der Leuchttechnik," issued in 1902—apparently the origin of "Leuchttechnik" as a word to describe lighting technicalities. A second period may be said to have originated with the work of Cohn and Weber about 1883. Both workers, followed by Upperborn, Bloch and others, studied the application of light and derived rules and data. (The Weber photometer, it may be noted, was devised as early as 1883.) Professor Teichmüller regards a third epoch as starting in Germany with the Osram "Lichthaus" this year. Much the same might be said to apply to other countries. We were occupied first almost exclusively with the rush of new illuminants, then with rules for their application. The present stage, illustrated by exceptionally wide propaganda in favour of better lighting, the organization of courses of lectures, demonstrations, etc., has as its main feature the attempt to communicate to the general public the lessons we have been learning; to raise the status of illumination and to make good methods of lighting general practice.

This is the problem which is now occupying the attention of those interested in illuminating engineering in most of the chief countries of the world, and no doubt during the coming months we shall be able to mention other instances of activity.

## The Illumination of St. Peter's at Rome

The propriety of lighting up churches on festive occasions has often been debated, and the views taken in various countries differ. An instance occurs in the special illumination of St. Peter's in Rome, on May 17th, on the occasion of the canonization of the "Little Flower" Teresa. It is stated that at sunset the façade and dome of the basilica were illuminated by electric light, whilst an hour later, thousands of oil flares, placed at intervals on the ribs of the dome and over the façade, were also lighted up. Another feature was the illumination of the colonnades, with their statues, by two rows of lanterns and by flares supported on wooden columns ten feet high. It is stated that this is the first time since 1870 that the church has been fully illuminated.

## Lighting Legislation in the United States

At a recent council meeting of the American Illuminating Engineering Society, Mr. L. B. Marks reported that the adoption of a code of lighting by the States of Michigan and Minnesota is being favourably considered. Further investigations in this direction are also being made in Iowa. In Colorado a measure for standardized lighting in places of employment, education and amusement has been rejected, but a similar Bill will be submitted at the next session.

## A Study of Mirror Reflectors

At the fourth annual meeting of the Illuminating Engineering Society in Karlsruhe on June 12th, Dr. Teichmüller presiding, a series of papers dealing with mirror reflectors was presented. Professor Dr. G. Gehlhoff dealt with the physical and technical principles underlying mirror reflectors, Dr. Hartinger with their design and manufacture. Dr. N. A. Halbertsma dealt with motor headlights, E. Herr Thilo with their use in connection with aerial navigation, and Dr. Joachim with their use in kinema projectors—all fields where reflectors with highly-polished surfaces have special applications. A technical communication by Professor Teichmüller and Herr Steinmann summarized some investigations on simple forms of reflectors of this class. The discussion was supplemented by an exhibition of reflectors at the Karlsruhe Lichttechnische Institut.

## Electrical Progress in Spain

We notice that Spain, in common with most other foreign countries, is now going ahead with schemes of electrification. Amongst recent steps and projects may be mentioned the electrification of a section of the Madrid-Gijon Railway, and progress in connection with the underground railways of Madrid and Barcelona. Work under way on hydro-electric schemes totals about 47,000 h.p. These developments are of interest, because any marked advance in facilities for electrification is usually accompanied by ultimate progress in lighting, and on this subject we do not as a rule hear much from Spain.

# TECHNICAL SECTION

COMPRISING

Transactions of The Illuminating Engineering Society and Special Articles

*The Illuminating Engineering Society is not, as a body, responsible for the opinions expressed by individual authors or speakers.*

## A Survey of Lighting in 800 Retail Shops

### DISCUSSION

*(In what follows we give a summary of the discussion of the paper on the above subject by Messrs. W. J. Jones and H. Lingard, read before the Illuminating Engineering Society on May 19th. The paper appeared in our May issue pp.* 119-125.*)*

MR. L. GASTER, in opening the discussion, said that the paper was an important piece of work, and showed the need for educational effort in this field. In drawing conclusions one should, however, remember that it was naturally only possible to obtain data on more than a very small proportion of the total number of shops of any particular trade. He fully agreed with the authors' comments on the bad practice of using bare lamps, but he suggested that the consumption in watts per foot of run was not in itself an indication as to whether it was well lighted. In each case it was necessary to bear in mind the requirements of a trade, the nature of the street in which a shop was situated, and other factors determining the amount of illumination required. He hoped that the authors would follow up their general survey by a detailed examination of certain classes of shops, with the co-operation of window-dressers and display men.

MR. A. GABRIEL remarked that the use of coloured lighting, though valuable in certain cases, needed care. If the appearance of objects in windows was materially altered by the colour of the light, people might feel that that they had been misled.

MR. E. STROUD complimented the authors on their idea of making this comprehensive survey of shops and presenting such useful data. He thought, however, that "excellence" in illumination required careful definition, and that the illumination in foot-candles was a better basis of comparison than the consumption of electrical energy. Excellent results could often be obtained with 50 watts per foot run. He was struck by the general use of bare lamps revealed by the paper. Improvement in this respect could be most readily brought about by contractors who should aim at not supplying a lamp without also furnishing suitable equipment for use with it. He hoped that an abstract of the paper would be widely circulated amongst contractors.

MR. W. MILLNER also congratulated the authors. The paper was a monumental work. One point that struck him was that apparently only about two per cent. of shops used artificial lighting for the interiors of display cases; it was surprising that the opportunity for an illuminated display should thus be neglected. He was also surprised at the figures relating to drapers. His own experience was that, apart from big stores, they were amongst the worst offenders in regard to "close up" lighting. He would not have expected that confectioners would come second on the list in regard to lighting over counters. The paper had shown where bad methods of lighting were most general. The number of shopkeepers who were still unconvinced in regard to the importance of good lighting was very considerable, and there was still a vast field for educational work.

MR. J. M. WALDRAM, after complimenting the authors on putting so much information at the service of members, remarked that many people still confused glare with illumination. The authors had given reasons why some systems were considered bad, but he thought that the information as to why others were considered excellent required to be supplemented, so that the lines on which to proceed might be known. A great deal depended on the use that was made of the energy consumed, and the nature of the reflectors and equipment largely determined whether the installation was a good one or the reverse.

CAPTAIN W. J. LIBERTY also praised the paper, and remarked that most of the information had been given for the first time in the history of artificial lighting in relation to trade. He endorsed Mr. Gaster's suggestion that the shops already visited should be further studied, in order to help the proprietors to attain the desired standard of efficiency. It was evident that saturation point had not been reached in regard to shop lighting. He would have liked to have heard something about the use of flashing signs on counters. Such signs were sometimes used as an indication that certain goods were available, and when the shop was closed to the public they could be removed to the windows.

MR. R. A. LOWER also referred to the need for educational work amongst shopkeepers. It would be interesting to know the relation between the lighting bills and rent and turnover. He felt sure that the cost of lighting would prove to be only a small proportion of other standing charges. As an instance of misuse of lamps he recalled a notice in the window of an optician, warning people to avoid eyestrain, but illuminated by a bare lamp! Were any of the shops visited illuminated by outside lamps?

MR. W. E. BUSH said that authorities differed in regard to the foot-candles recommended for lighting the interiors of shops. The E.L.M.A., with which he was associated, recommended eight foot-candles. It was sometimes suggested that this figure was too high, yet in many cases it was exceeded in practice, and he thought that it was a reasonable value to recommend. There was no doubt that shop lighting represented an important field for propaganda. He understood there were 4,693 boot shops in London, and of these probably at least 2,000 required relighting. He thought that the best way to proceed was by mass attack. In the autumn a national campaign for better lighting was proposed, and

no doubt the figures presented in the paper would then prove very useful.

MR. E. S. EVANS, speaking as one of the investigators, said that when the survey was originally proposed many people were rather dubious as to the results. The information was acquired largely through the co-operation of supply companies who had enabled them to form a good idea how matters stood in various cities and towns. He had been struck with the evident desire of many shopkeepers to obtain knowledge on better lighting. Some were afraid to go direct to contractors or supply companies for information, in case they might be let in for a large bill for improvements; but they were keen to discuss the matter with investigators realizing that they were more or less independent. Only in one case did he meet with a refusal of information. The foot-candle meter was a cause of great wonderment. When its mysteries were explained shopkeepers were much impressed. In one case a provision merchant using a large number of 40-watt vacuum lamps was dissatisfied with his lighting, and asked what he ought to do in order to bring it up to the suggested standard, viz., 10 foot-candles. When he was told that the substitution of 60-watt lamps would do it he asked the speaker to come back later. When he did so he found that 60-watt lamps had been introduced throughout the shop, bringing the illumination up to nine foot-candles. In most of the districts visited lectures had been given and very long hours were put in, so that it would not have been possible to visit a larger number of shops.

MR. R. C. HAWKINS, also an investigator, recalled some of his experiences. His reception had been somewhat varied, but on the whole he found that the people in shops already well lighted were most interested and sympathetic. They appreciated the benefits of good lighting and in practically every case were keen to improve their lighting and make progress. A number of the larger shopkeepers did not mind so much what they paid for lamps and fittings but grumbled about the cost of current. In such cases he had pointed out that the lighting bill was very small compared with the total overhead charges.

It was often said that Scotsmen were very thrifty and economical, but the shops in Glasgow were, on the whole, very much better lighted than those in London. This showed that although the Scot was thrifty he was also farsighted and realized that by improving his lighting he was also increasing his profits in the long run.

MR. GEO. HERBERT congratulated the authors on their paper. He wished to emphasize what Mr. Gaster had said in regard to shop-window lighting being affected by the general standard of lighting in their vicinity. One found that the chief aim of a shopkeeper was usually to make his window "stand out," and it was commonly believed that the window with the greatest brightness had the greatest attractive power. It was necessary to consider this factor, and how far modes of attracting attention—such as changing colour-display—could be combined with permanent good concealed lighting of the window. Mr. Herbert also remarked that the authors appeared to have concentrated attention mainly on lighting from the top of the window, a usual method but not the only one. He had met cases of effective lighting from below.

MR. GOLDMAN pointed out that until the shopkeeper was educated with regard to how to dress his display windows he would not entertain the proper lighting of them. Display men in this country had a hard task to perform in getting modern and progressive methods adopted. People were very conservative in this respect. They had been told that 60 per cent. of drapers adopted display methods; that figure was an eye-opener to him, and he rather doubted it. Until drapers had been persuaded that it was a mistake to fill their windows right up to the top of the glass they would not be open to receiving progressive suggestions with regard to lighting. Messrs. Woolworth had built their shops to suit their trade, and their methods of lighting were quite novel and different from those commonly used. Shop-fitters in this country had been largely responsible for the present conditions owing to their reluctance to break away from particular styles of building. Only recently had there been any marked improvement in shop-front design, and it had required great effort to get the new ideas adopted. Future progress depended on co-operation between the illuminating engineer and the progressive display man.

MR. C. HUGHES said that the paper contained a great deal of practical information upon which to base future work. He had been much interested in the percentage figures given, and agreed that the present position in regard to shop-window lighting was very unsatisfactory, and that shopkeepers were in great need of guidance on correct methods of lighting.

MR. MORTON said he assumed that the shops visited were not branches of multiple shop organizations. It would be interesting to know how many shopkeepers adopted the progressive method of keeping their lighting on after business hours.

MR. RAFFÉ remarked that the fundamental idea of window lighting was to attract customers. Light in any form had an attractive influence. Some shopkeepers attached great value to subsidiary outside lighting and had combined this with window lighting, making the whole a uniform scheme. The island site offered admirable opportunities for the display of goods and the lighting of them. He could not agree that drapers were extremely go-ahead in lighting matters; in many cases they were the worst offenders in that respect, largely because they attempted to make their windows into catalogues of contents instead of displays. With regard to the use of coloured lighting he thought that no one with any intelligence would assume that objects purchased would necessarily appear exactly the same as they appeared in a window thus lighted. The window was the right place to employ coloured light, whilst white light should be used in interiors. It was not enough merely to render goods visible. The effect must be pleasant and attractive. He thought that in lighting force of example was very powerful. If the first half dozen shops in a street could be induced to adopt good methods they would soon be copied by others. He noted that the survey dealt exclusively with electrically lighted shops, and would like to see a similar survey made in the case of shops lighted by gas.

MR. C. H. MERZ congratulated the authors on the paper and expressed the hope that there would be other opportunities of discussing the very comprehensive data that it contained.

MR. H. E. HUGHES (communicated): I would like to draw attention to the following points which I was unable to deal with during the discussion:—

Artificial daylight, whilst useful for correct revealing of colours, is unsuitable for general use as it is too cold to be attractive. The fact that it reveals colours well is quite secondary to the advertising value of a good display. The proper method is to set apart a room equipped with daylight lamps for the examination of coloured materials.

The most attractive window display is not necessarily the most brilliantly illuminated; with very brilliant illumination glare is usually present in some degree. Local bright lighting or spot-lighting of a clever display has a powerful attractive effect. Hence I question the correctness of adopting "watts per lineal foot of frontage" as the chief measure of excellence. The benefits of auxiliary lighting of shop windows during the daytime deserve attention. Finally, I would like to inquire whether cheaper electric energy in Glasgow is responsible for the better shop lighting, as compared with London, mentioned in the discussion?

THE CHAIRMAN (Mr. C. W. Sully) remarked that those who had criticized the survey because it had not gone quite so far as might be desired should remember that the work was very tedious and also expensive. He hoped that the present effort, which was the first in that direction, would be followed by others, and that members would vie with each other in undertaking supplementary surveys. It was natural that some of the results should not be in complete accordance with

individual impressions, but average results, such as those given, were far more valuable than isolated observations.

He agreed that it was most desirable and necessary to have the co-operation of display men, and as had been pointed out, the work of the architect had an important bearing on shop-lighting possibilities. The more that all such sections could be brought in contact the more they could help each other and themselves.

MR. W. J. JONES, after thanking members for the manner in which the paper had been received, said that a long time would obviously be needed to discuss the survey *in extenso*, for a great deal of information could be extracted from the available figures. In reply to Mr. Gaster he wished to say that the surveyors took every care not to pick out particular shops. To extend the survey indefinitely would be an impossible task, and it is felt that the survey conveyed a reasonable representation of conditions existing at the present time.

He fully appreciated the efforts that the British Association of Display Men had made to effect improvements, and it was largely through their efforts that advances in lighting could be made. Mr. Stroud had raised a pertinent point with regard to measurements of foot-candles as giving a basis for a degree of excellence. He thought, however, that Mr. Stroud would agree that it was impracticable to induce those in charge of a shop to disarrange the contents of a window in order that people could step inside and take measurements of illumination. The criterion in regard to wattage was convenient and helpful; in some cases statements of foot-candles would, in themselves, be of little value, for the multiplicity of shop-window reflectors now available give slightly different polar curves, which, while not affecting the general illumination of a window, would materially affect the foot-candles obtained in any position. Besides which exactly where should the readings be taken? Further subdivisions of degrees of excellence would have raised many conflicting problems, such as could not readily be dealt with in tabular form. "Concealed lighting" was intended to convey any form in which the actual sources of light were not visible from outside the window. He agreed that in some cases it was advisable to have concealed sources at the base of the window; but the great majority of windows were best lighted from the top. Outside lighting was not, in general, satisfactory; considerable care had to be taken to avoid troublesome reflections of light sources in the glass.

It was surprising to find that the figures for drapers came out as they did. The authors, however, had tried to discriminate between the draper and the outfitter; he thought it would be found that in the latter case the method of lighting was generally poor, doubtless owing to the tendency to adopt close-dressing, with goods brought right up to the glass of the window.

In regard to Mr. Raffé's remarks, traders who were keenly interested in illumination would be able to secure adequate public lighting to reinforce their displays. In some cases shopkeepers in a street had combined together in order to ensure that the public lighting outside was what they desired. With regard to discriminating between different towns, in regard to shop lighting, it was hoped that further information would be acquired enabling this to be done.

With reference to the communication of Mr. H. E. Hughes, I am in entire agreement that artificial daylight in shop windows must be used with discrimination. There are, however, a number of instances in which it has been successfully applied; its merit being not only that of making white goods appear more white and showing other materials in more natural shades, but also the advantage of making a window conspicuous compared with those in the vicinity. Most people would agree that lighting alone is not the sole factor which makes a window attractive, but I am of the opinion that it is probably the most important factor.

MR. H. LINGARD, dealing with Mr. Gaster's remarks, explained that the forms drafted for the purpose of the inquiry had been much extended from their original simple form. Nevertheless it had not been found possible to include all material factors such as the depth of window; from five to six feet would seem to be an average figure.

With regard to possible misrepresentation of goods by the use of coloured light, the British Association of Display Men was generally in agreement that the use of colour made the display much more attractive, but where it was adopted the window dresser and the light expert should certainly consult together. Similarly, in regard to show cases, the lighting problem would be much simplified if the cabinetmaker was informed of the illuminating engineer's proposals so that the cabinet could be designed to accommodate the lighting units.

He thought that the table in the paper answered Mr. Waldram's inquiry with regard to the determination of the excellence of an installation. He agreed that, if possible, the shops should be revisited. There were about 2,000 shops owned by opticians, and the authors had felt that the number of such shops included in their survey was insufficient to enable data to be presented for this class. But, speaking generally, such shops were not well lighted and glare was predominant. There was a passage in the paper referring to outside reflectors. About 370 such units were found in the 800 shops visited. Approximately 15 per cent. of the shops adopted after-hour lighting.

A very cordial vote of thanks to the authors was moved by the CHAIRMAN, seconded by MR. L. GASTER, and carried unanimously. A vote of thanks to Mr. C. W. Sully for presiding and to the E.L.M.A. Lighting Service Bureau for their hospitality during the evening terminated the proceedings.

## America's Model Shop

We notice that, according to a note in the Transactions of the American Illuminating Engineering Society, the formal opening of "America's Model Shop" took place on May 16th on the Broadwalk at Atlantic City. The shop was exhibited to merchants as an example of up-to-date and artistic lighting equipment. The lighting features were designed by a special committee of the National Electric Light Association, all of whom were members of the Illuminating Engineering Society. There are six display windows each treated in a different way. The largest has a frontage of 30 feet and is 17 feet deep, and portrays a Georgian living room furnished by leading manufacturers. This shop is to be the permanent headquarters of the National Art and Industry Exposition and the Centennial Alumni Association.

## Measurements of Illumination during the Solar Eclipse of January 24th, 1925

Through the courtesy of the Illuminating Engineering Society in the United States we have received an advance copy of notes on the above subject compiled by Mr. Preston S. Millar. The idea of obtaining these measurements was taken up with enthusiasm, and expeditions to nine different localities were organized, tests being in general made at the summits of high hills. Besides ordinary photometric measurements supplementary tests were made with photo-electric cells and thermopile equipment. Results obtained by the three methods seem to agree well. The eclipse being total in the United States, very low minimum values of illumination were recorded. From these and previous data it appears that an average minimum illumination at totality of about 0·25 foot-candles is to be expected, though much depends on the nature of the atmosphere.

The expeditions sought the advice of Dr. Kimball of the U.S. Weather Bureau, Professor E. W. Brown, of the American Astronomical Society, and other experts on astronomical matters. Results are well arranged with the aid of diagrams and illustrations, and in an appendix some particulars of past determinations are given.

# Lectures on Illuminating Engineering

## (Under the Joint Auspices of the Illuminating Engineering Society and the Electrical Engineering Dept. of the Polytechnic [Regent St.])

*(Continued from Page 129, May, 1925.)*

THE four final lectures of this course were given on May 18th, 20th, 25th and 27th. On Monday, May 18th, Mr. L. Gaster resumed the consideration of industrial lighting, and also dealt with the lighting of shops and show windows.

### Problems in Industrial Lighting; The Lighting of Shops and Show Windows.

In the early part of his lecture Mr. Gaster briefly recapitulated his previous remarks in regard to recommendations on industrial lighting, and exhibited some slides illustrating the values proposed by the Home Office Departmental Committee and in various American codes. It was pointed out that the recommendations made in this country and the United States, and also recently by the Illuminating Engineering Society in Germany, were in general agreement. It was remarked, however, that the provision of high illumination was not in itself sufficient, and that attention to such matters as absence of glare and proper direction of light was equally important. Each industry presented special problems that could best be solved by an expert who was both in touch with the latest developments in illuminating engineering and familiar with the industrial processes concerned. A number of lantern slides showing varied industrial lighting installations were shown to illustrate this point. One of these showed overhead illumination with gasfilled lamps yielding 8-10 foot-candles in a clothing factory; but the lecturer drew attention to the severe requirements when dark materials had to be illuminated, and in some cases these were best met by local lighting. This point was illustrated by examples of local lighting, both with gas and electricity, in boot factories, and special systems of providing local illumination at the point of the needle by small lamps mounted on sewing or boot-making machines were explained. Some reference was next made to the special lighting required by the complicated processes of the textile industry. Other slides showed right and wrong directions of light for various tools, and attention was drawn particularly to the need for avoiding sharp and confusing shadows from the edges of circular saws, and tools with cutting edges, which might occasion accidents and spoiled work.

Passing on to the lighting of shops and show windows, the lecturer drew attention to the importance attached by progressive traders to good illumination as a commercial asset. Good lighting was a great aid to "quick selling" during rush hours, and created a favourable impression in the minds of customers. Similarly experiments had shown that the "drawing power" of a shop window depended very much on the way in which it was illuminated. In the leading stores concealed lighting (the direction of light on the goods by sources equipped with reflectors and screened from the view of people on the pavement) was now generally adopted, but in retail shops incorrect methods and the use of unscreened bare lamps in the window were still too frequent. This matter would be referred to in a discussion at the meeting of the Illuminating Engineering Society on the following evening, to which students were invited. Mr. Gaster pointed out that window dressing and lighting should be considered together. The practice of making a window a catalogue of the contents of the shop, by filling the window with goods placed quite close to the glass, made proper lighting extremely difficult; much better effects could be obtained when "display dressing," involving the artistic arrangement of a few choice objects, was adopted, and where the co-operation of the lighting expert and the display man led to good results. Reference was also made to the use of "artificial daylight" in cases where correct revealing of colours of objects is of importance, and to special methods of using coloured light in order to secure an attractive display. It was pointed out, however, that the use of coloured light in a show window needed discrimination, so as to avoid prejudicing the appearance of objects. In conclusion a series of illustrations of flood-lighting, applied to the exteriors of commercial buildings and stores, was shown, and the lecturer pointed out the value of such methods as a distinctive advertisement. He also referred to the growing practice of keeping show windows lighted up after business hours, the lights being, if necessary, extinguished by an automatic time-switch at a predetermined hour. This likewise formed a very effective advertisement, which was also inexpensive when compared to the rental and general overhead charges of a store.

Acknowledgment was made to the assistance of the General Electric Co. Ltd., Benjamin Electric, Ltd., Holophane, Ltd., the British Commercial Gas Association, and others who had kindly furnished slides for the two lectures.

### Lighting in Relation to City Traffic.

Mr. J. S. Dow opened his lecture on the above subject on May 20th by a brief historical introduction, showing how public lighting, originally a duty imposed on householders, ultimately came to be recognized as a public obligation. He showed several slides illustrating the progress made in illuminants for street lighting since the days of the oil lamp, using as illustrations the present lighting with high-pressure gas of Pall Mall, one of the first streets to be lighted by flat flame burners about a century ago, and the conditions on the Thames Embankment during various periods. He drew special attention to the extended use of gasfilled lamps of high candle-power, and to the advances made possible by superheated low-pressure gas cluster units, and mentioned some interesting experiments in Berlin with a new long-burning enclosed flame arc.

Mr. Dow then proceeded to review the main objects of street lighting and the essentials of good illumination in public streets. He drew attention to the continually growing number of street accidents; there was little doubt that the number occurring after nightfall was abnormal and that many accidents which occurred in the night could be avoided by better lighting. Requirements included sufficient illumination, absence of glare and avoidance of sudden contrasts in brightness; it was difficult to secure maximum illumination midway between lamps without some degree of glare, so that a compromise was necessary; but conditions were much alleviated by recent designs of lanterns, which aimed at diffusion of light as well as direction of rays in the desired direction. Some difference in opinion existed as to the amount of light that should be directed on to the roadway. While this was the most important function, it was recognized that an important street gained in appearance if a fair amount of illumination was allotted to faces of buildings. Reference was made to the system of grading streets adopted by the Joint Committee on which the Illuminating Engineering Society, the Institutions of Gas and Electrical Engineers and the Institution of Municipal and County Engineers were represented. The lecturer expressed the view that in any really important street carrying dense traffic a minimum horizontal illumination of 0·1 foot-candle was desirable; though due regard should be paid to the total amount of light which a street received. Attention was drawn to the exceptionally high illumination recently attained in the vicinity of Charing Cross, and some slides lent by the General Electric Co., Ltd. illustrating the conditions were shown. Some further slides illustrated war-time lighting. The drawbacks of the "patchy" illumination produced by the initial methods of screening, afterwards improved, were clearly shown.

Some reference was next made to other aspects of public lighting such as the lighting of stairs—exemplified in the City of Glasgow—the lighting of subways and tunnels, and the use of special luminous indicators to traffic, which has been developed in American cities. The lecturer emphasized the importance of avoiding a sudden contrast in brightness when persons emerged from tunnels, leading to dazzling of the eyes and possible accidents.

The motor-car headlight problem was closely related to public lighting. Some methods of relieving glare from headlights were mentioned, but it was pointed out that here again a compromise between two almost irreconcilable requirements, the provision of a sufficiently powerful beam for safe driving and the avoidance of glare in the eyes of approaching drivers and pedestrians, was necessary. The most hopeful solution lay in better street lighting, rendering the use of powerful headlights in city streets unnecessary.

In conclusion, the drawbacks of the present system by which each district or parish provided its own lighting was pointed out—as illustrated by the complex conditions in London and the changes that occurred as one passed from one local area to another. It was urged that street lighting had become a national rather than a parochial matter, and the special new roads and arterial thoroughfares, on which large sums of money were being spent, were mentioned as cases where a national outlook was needed. Such roads would only serve their purpose effectively if proper lighting were provided. Within recent years the desirability of public lighting being dealt with by an appropriate central authority which could undertake tests, arrange streets in terms of their lighting requirements, and bring about more uniformity had frequently been emphasized.

## Lighting on the Railways.

In dealing with the above subject Mr. A. Cunnington (Lighting Engineer to the Southern Railway) first drew attention to some of the features which differentiated it from other problems in lighting, three points being mentioned, viz., firstly the paramount importance of safety both of the public and of the railway servants, secondly the value of lighting for expediting business which has to be carried out to time-table, and thirdly the value of good illumination in attracting traffic, and its influence on the general reputation of a railway. Passing reference was also made to the lighting of advertisements and the enhanced revenue obtained from these when made visible after dark, but this work was of course not strictly connected with the operation of a railway.

In going into fuller detail regarding the above three points the question of platform lighting was considered, and reference was made to the classification of platforms into three groups, which has hitherto been fairly generally recognized, but the lecturer expressed the view that really not more than two classes need be considered, namely, those stations where traffic is considerable, trains frequent, and passengers always waiting on platforms, and those stations which are only intermittently used. Large terminals would naturally fall into class one as regards platform lighting, and their extra importance should be recognized by special lighting over the concourse, or space for public use, and also by particularly good lighting in booking halls, waiting rooms, etc., which are generally more impressive architecturally at terminal stations than elsewhere. Slides were shown giving tabulated results of illumination measurements on platforms under various conditions of lighting, and the general tendency to improve standards was remarked upon. Examples were shown of reflectors suitable for platform lighting, and photographs of their application taken both by natural lighting and by artificial light. The importance of lighting in shunting yards was emphasized, and the difference in requirements between the latter and platform lighting was indicated. Whereas in platform lighting illumination in the horizontal plane is principally required, what matters most in a shunting yard is the light received by vertical surfaces, such as the ends of moving trucks or the sides on which labels and shunting instructions are fixed. It was pointed out that there is difficulty in providing suitable illumination owing to lack of space for lamps to be placed at frequent intervals in most existing lay-outs. The special lighting required at the points for shunting in marshalling yards, especially that necessitated when working a hump yard, was indicated by blackboard sketches.

In passing to the second section of the subject Mr. Cunnington pointed out that the efforts of the lighting engineer were not always appreciated by the staff, especially if an improvement in lighting were carried out at the expense of some privilege such as a gas ring previously enjoyed by the staff, or if some standing excuse of poor illumination were removed. He, however, pointed out that in general there is a very widespread desire for efficient lighting, and undoubtedly more importance is attached to this now than was the case some 10 or 15 years ago. A number of slides were exhibited showing special applications of lighting giving efficient illumination on clocks, weighing machines, time-tables signals, etc. A brief explanation was given of the interior arrangement of the time-tables exhibited at Waterloo Station, in which the sheets are placed between plates of glass and lighted from behind. Attention was drawn to the screened lighting in signal boxes, first used as a war-time measure and afterwards adopted as being the most satisfactory for permanent use owing to the better vision afforded to the signalman when looking through the windows of the box with undazzled eyes. Some illustrations of escalator lighting were given, and a brief reference was made to railway carriage lighting, with some examples, including a diagram which showed what was considered to be the best method of lighting ordinary carriages as apart from those on the tube railways.

Dealing briefly with the third section, Mr. Cunnington spoke of the importance of lighting station nameboards and the small name tablets attached to station lamps, and he demonstrated the progress that has recently been made in methods of exhibiting the name and illuminating it clearly at night.

He also referred to the very large nameboards, such as the one installed at Wimbledon, which were now being fixed experimentally with a view to indicating the whereabouts of the station to passengers shortly before the train draws up to the platform. In conclusion, some examples were given of the special roof lighting at Waterloo Station, and the flood-lighting of the Memorial Arch, showing what could be done in the way of decorative lighting, provided sanction could be obtained for the expenditure.

## The Use of Light in Modern Advertising and Publicity.

The final lecture, on May 27th by Mr. G. P. Garbett, dealt with the above subject. After referring briefly to early forms of electric letter signs, which were developed almost as soon as the electric incandescent lamp made its appearance, the lecturer reviewed recent advances, both in illuminants and in the design of signs. He pointed out as an important landmark the great advance made possible by the introduction of metal filament lamps. Apart from their higher efficiency, which greatly diminished the expenditure of energy on a sign, the fact that the metal filament had attained its full brightness so much more rapidly after switching on was all-important. This quality had rendered possible the development of "animated" and motion signs, of which a great variety, installed both in this country and abroad, were shown by a series of lantern slides.

The difference in evolution in this country and America was pointed out; in the latter country efforts were concentrated mainly on producing sky-signs of very large size, whereas in this country public opinion had a restrictive influence and devices were on a smaller scale but equally original and effective in design.

Mr. Garbett pointed out the complexity of the conditions governing the performance of animated signs; much care in timing the various movements was needed in order to produce the right impression, and in some cases many experiments had to be made before the correct combinations were secured.

Improvements in methods of mounting lamps for letter signs were discussed, and slides were shown illustrating the need for effective insulation and protection against weather. It was remarked that Edison screw sockets were essential; experience showed that the bayonet holder was unsatisfactory for this field of work. It was also shown how the early system of mounting lamps on a flat surface, which gave rise to confusion when a sign was viewed from the side, had given place to the channel-letter, by which interference of stray light was prevented. Reference was made to the use of colour-sprayed lamps, which have played an important part in some recent large signs.

The lecture was illustrated by a large number of slides, some showing how impressions of movement were created, others showing transparencies and the illumination of large posters by night. In conclusion, some effective examples of flood-lighting were shown, the lecturer remarking that this was essentially an example of the use of light for advertising and publicity. He alluded to the complexity of existing regulations bearing on the erection of signs, which varied greatly in different cities and were in many cases clearly obsolete. Some means of attaining simplicity and uniformity in such regulations was much to be desired.

At the conclusion of the lecture several signs, kindly sent by Mr. E. T. Ruthven Murray, were exhibited, after which Mr. Gaster gave a short address summarizing the aims of the lectures, which were considered to have been a great success. He stated that, as a result, the Polytechnic were now proposing to make arrangements for a permanent course in illuminating engineering.

## Modern Street Lighting

IN a paper on the above subject, presented at the I.M.E.A. Convention at Brighton this month, Mr. Haydn T. Harrison referred to the difficulty of the problems met with in connection with public lighting, owing to the large number of factors involved. The conclusion could be drawn from statistics that the number of accidents at night was rapidly increasing, and that a number of these accidents could be prevented by adequate illumination. Meantime, while the standard of artificial lighting had risen in other directions, street lighting, with a few notable exceptions, remained much the same as before the war.

It was recalled that Mr. Preston S. Millar, in a paper before the American Institution of Electrical Engineers in 1915, concluded by saying that all the objects of satisfactory street lighting could be served, when appropriations are adequate. The natural question is "When are appropriations adequate?" In order to throw light on this point the author summarized statistics bearing on about 100 examples. He concluded (a) that the average rate allotted to public lighting is 5·3d., (b) that this represents 3·36 per cent. of the total rates levied, (c) that the rate varied from 1½d. to 10d., but was generally between 3d. and 5d., (d) that it was not materially affected by the use of gas or electricity, or by a combination of the two, (e) that the lowest rates were in Metropolitan Boroughs, the lowest being 1½d. in an area electrically lighted throughout, and the other 1⅞d. in an area where electric lighting and gas lighting were both used. It was also interesting to note that the lowest rate of all was obtained in a borough which is considered to be exceptionally well lighted. After dwelling on the public importance of good street lighting Mr. Harrison thought that ratepayers would agree that the present appropriations are not adequate, and would wish more money to be spent on a service from which they derive direct benefit.

In the next section of his paper Mr. Harrison reviewed various attempts to define good street lighting. The chief factors specified in his own paper before the International Illumination Commission in Geneva in 1924 were: (1) Visibility of objects on the road; (2) visibility of objects on the footpath; (3) low brilliancy of light-sources in the area of vision; (4) even illumination; (5) minimum obstruction to traffic of pedestrians; (6) reliability and constancy of lighting sources. He also dealt with the method of grading adopted by the Joint Committee on which the Illuminating Engineering Society, the Institution of Electrical Engineers, the Institution of Gas Engineers, and the Institution of County and Municipal Engineers were represented, remarking that both from the police and traffic standpoints the minimum illumination desirable for streets of the lowest grade should not be less than 0·025 foot-candles. From various schedules that have been issued he suggested that for streets conveying main traffic (streets of all classes) the minimum illumination should be 0·1 foot-candles.

In dealing with visibility, illumination and glare the author discussed various methods of dealing with these more or less conflicting elements, quoting data which showed, in an arbitrary manner, the diminution in glare with increased height of lamps. The process of testing street lighting was described, the author insisting on various precautions and drawing the inference that it is not advisable to guarantee an accuracy greater than 10 per cent.

Statistics collected by the author referred to 5,675 miles of streets lighted by 190,000 gas lamps and 2,092 streets lighted by 70,600 electric lamps. It appeared that in electrically-lighted streets the lamps were on an average 180 feet apart, in gas-lighted streets somewhat nearer (155 feet apart); this was doubtless due to the practice of increasing the spacing when high power electric lamps were introduced. It might be assumed that, in the case of conditions applying to 90 per cent. of streets lighted by gas or electricity, the use of 50 or 100 candle-power lamps mounted 10 to 12 feet high and spaced at 150 feet or over would result in a minimum horizontal illumination of from 0·0015 to 0·003 foot-candles—a condition little better than beacon lighting. Exceptions, however, exist. Cases are on record in which, by the use of special methods, this minimum illumination has been increased from 20 to 60 times without increasing the lighting rate. In reviewing recent illuminants the author strongly emphasized the necessity of equipping gasfilled lamps with suitable reflectors; there is probably no form of street lighting which appears so unsatisfactory as the use of these lamps with their concentrated filaments exposed against the dark sky.

Finally the author showed how, by deliberately allotting the light available to its main object, the illumination of the road surface, the necessary illumination could be obtained with a very moderate expenditure of energy. Various forms of "longitudinal" units permitting concentration of light were described, including the Holophane types, and in conclusion various methods of control and automatic switching were briefly discussed.

# A New Criterion of Street Lighting Excellence

(By the Research Staff of the General Electric Co.)

Work conducted by

L. B. W. JOLLEY, M.A., (Cantab.), M.I.E.E. and C. A. MORTON, B.Sc.

*Summary.*—This paper discusses a suggested method of preparing the design of a street lighting installation.

THE general problem of a street lighting specification is to design an installation from the illuminating engineering viewpoint, which will be reasonably efficient, both financially and scientifically, and which will comply with all requirements, physiologically and psychologically, and meet with the approval of the local authorities and police. This comprehensive requirement seems impossible of fulfilment at the present time, and in the present article the only design features considered are those which have to be faced by every engineer who installs a new system of lighting apart from the questions of glare, cost, etc.

In the first place, it should be laid down as axiomatic that there can be no such thing as "fashion" in scientific lighting, and that therefore provided that traditional methods are based on good practice there can be no excuse for a change unless such a change be coupled with scientific improvement. This statement, on the other hand, must not be camouflaged so as to form an excuse for a policy of inaction, but only to ensure that progress is sound and sensible.

There are two main systems of street lighting at the present time employing (1) the asymmetrical and (2) the symmetrical distribution of light.

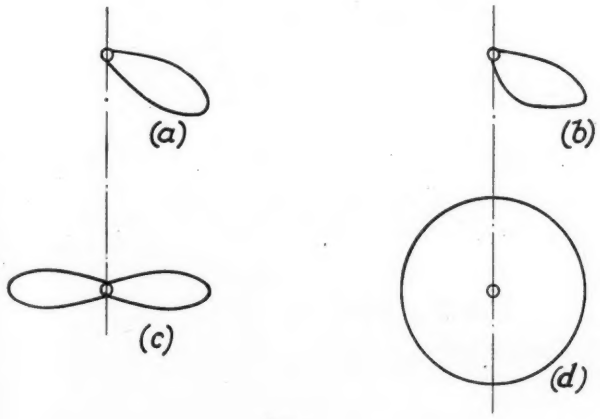



FIG. 1.

These two systems are illustrated in Fig. 1, where (*a*) and (*b*) represent the polar distribution in a vertical plane through the source of light in the two cases, and (*c*) and (*d*) the distribution in an horizontal plane. Thus the symmetrical distribution can be designated by a solid of revolution about a vertical axis through the source of light, whereas an asymmetrical distribution cannot be so represented.

It will be apparent that in the case of the asymmetrical system the light can be so refracted that it is more or less confined to the roadway itself, whereas in the symmetrical system the light is dispersed approximately evenly in all directions in an horizontal plane.

The terms directive or non-directive lighting are restricted to cases where a reflector or refractor is or is not employed to direct the light in any one direction in a vertical plane, and thus both (*a*) and (*b*) in Fig. 1 represent directive systems; in fact all modern and scientific lighting must be directive in principle, and no other system will be considered here.

The relative merits of the two systems (1) and (2) will be discussed later, but the variables which affect the resulting lighting may be classified as follows:—

(*a*) The height of the light source.
(*b*) The spacing/height ratio.
(*c*) The polar distribution.
(*d*) The diversity factor, i.e., the ratio of maximum to minimum horizontal illumination in a span due to the light from two lamps.
(*e*) The horizontal illumination.
(*f*) The direct illumination, i.e., the illumination on a plane at right angles to the ray of light.
(*g*) The vertical illumination.
(*h*) The direction of the maximum candle-power from the light source.
(*j*) The watts input.
(*k*) The span.
(*l*) The lumens output.

These quantities are designated in what follows by the symbols given below and in Fig. 2.

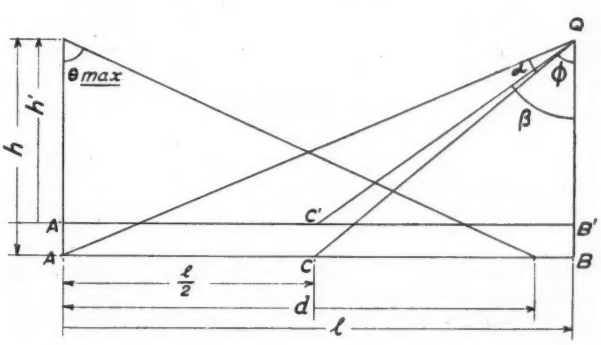



FIG. 2.

I the c.p. in any direction.
$I_V$ the c.p. in a direction vertically under the lamp.
$I_{\theta max.}$ the maximum c.p.
$I_\phi$ the c.p. directed to the centre of the span.
$L_H$ the horizontal illumination at any point.
$L_C$ the horizontal illumination at span centre.
$L_D$ the direct illumination at any point.
$L_V$ the vertical illumination at any point.
F lumens output.
W watts input.
h the height from the source of light to the ground.
h' ditto, to the working plane.
$r = l/h$ the spacing height ratio.
$\frac{\text{Max. L}}{\text{Min. L}}$ = Diversity factor.

Therefore $h = h' + 3{\cdot}3$ feet, and in what immediately follows the readings of illumination are taken on an horizontal plane 3·3 feet above the ground. Later a simplification is effected by taking all readings at the ground level, but generally a dash signifies a reference to the 3·3 foot plane.

The other quantity, which is sometimes of value is that connecting the angle $\alpha\ (=\theta - \phi)$ with the spacing height ratio r, sometimes called the "glare angle."

This is given by the relation

$$\tan \alpha = \frac{r}{2 + r^2}$$

and the curve connecting these two quantities is given in Fig. 3.

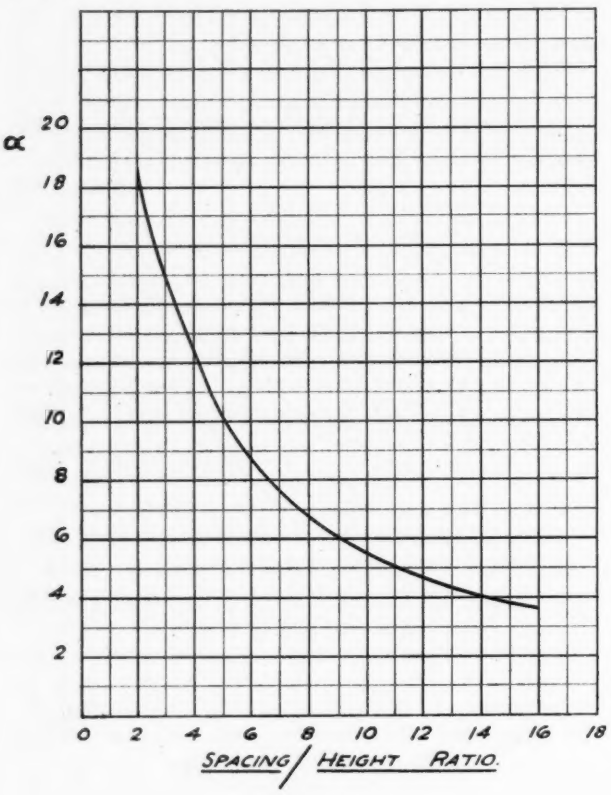



FIG. 3.

Further there is the relation

$$\tan \theta_{max.} = \frac{d}{h}$$

which determines the point in the span to which the maximum candle-power is directed. The angle $\theta_{max.}$ is, of course, usually fixed for any one particular fitting.

From this

$$\frac{\tan \theta_{max.}}{r} = \frac{d}{h} \times \frac{h}{l} = \frac{d}{l} \quad \ldots\ldots(1)$$

The horizontal illumination at any point can be shown to be

$$L'_H = \frac{I \cos^3 \theta}{h'^2} \quad \ldots\ldots(2)$$

where $\theta$ is any angle measured from the vertical to a line through the source. The direct illumination, which is the illumination at right angles to the direction of the ray of light, is

$$L'_D = \frac{I \cos^2 \theta}{h'^2} \quad \ldots\ldots(3)$$

and the vertical illumination is

$$L'_V = \frac{I \cos^2 \theta \sin \theta}{h'^2} \quad \ldots\ldots(4)$$

Thus it is seen that

$$\frac{L'_V}{L'_H} = \tan \theta \quad \ldots\ldots(5)$$

and this ratio is independent of all other variables.

Also

$$\frac{L'_H}{L'_D} = \cos \theta \quad \ldots\ldots(6)$$

and

$$\frac{L'_V}{L'_D} = \sin \theta \quad \ldots\ldots(7)$$

whence

$$L'^2_H + L'^2_V = L'^2_D \quad \ldots\ldots(8)$$

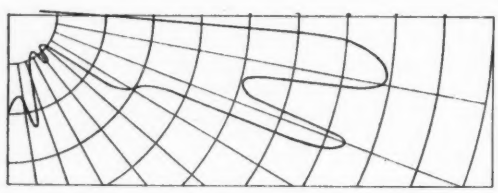
the above formulæ referring to the illumination from one light source alone. It follows from equation (8) that when $\theta = 45$ deg. $L'_V = L'_H$, and therefore

$$L'_D = 1{\cdot}41\, L'_H = 1{\cdot}41\, L'_V$$

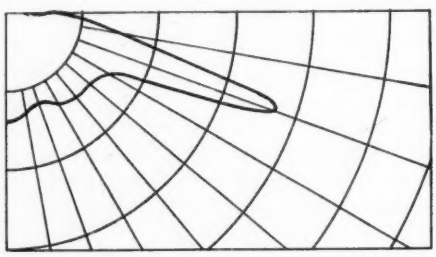
It may also be gathered that if the maximum candle-power from the light source is directed at any particular point at a given ratio of the span, i.e., if d/l is fixed, the spacing/height ratio r is fixed and cannot be altered, and conversely.

At this point it is advisable to investigate how the other various quantities are dependent on one another and on the given distribution.

In Fig. 4 the polar distributions of two fittings (Nos. III. and I. respectively) are shown; one of these, viz., No. III., represents a directive, symmetrical, and No. I. a directive, asymmetrical distribution. Later,



POLAR CURVE OF FITTING No.1
ASYMMETRICAL. FITTING WITH MIRRORS.



POLAR CURVE OF FITTING No.III
SYMMETRICAL WITH DOME REFRACTOR.

FIG. 4.

in Fig. 7, two other polar diagrams are illustrated, but for the moment only Nos. III. and I. are considered. To avoid confusion it is necessary to point out that although it may not be possible to employ a 1,000-watt lamp in every fitting, yet the candle-power output of each fitting has been corrected for this size of lamp, so that the results are comparable.

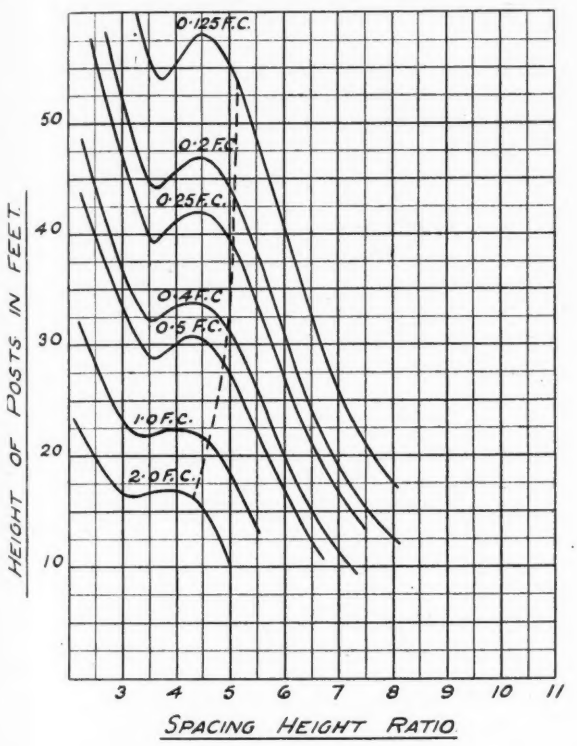
It can be shown that the illumination at the middle of the span is given by

$$L'_C = \frac{2 I_\beta \cos^3 \beta}{h'^2} = \frac{2 I_\beta}{h'^2 (1 + \frac{r^2}{4})^{3/2}} \quad \ldots\ldots(9)$$

two lamps only being considered, and where $I\beta$ is the candle-power directed to the mid-point of the span or point C′ in Fig. 2.

If various values are specified for $L_C$, then $I\beta$ is known from the polar distribution, and a series of curves can

be plotted connecting r and h. This cannot be accomplished directly, as there is usually no algebraical expression for $I\beta$ in terms of $\beta$ or r; but indirectly the difficulty is overcome by assuming convenient values for $\beta$ whence equation (9) can be evaluated, and hence h or h′ can be ascertained. As $d/h = \tan \theta_{max.}$ and $\theta_{max.}$ is known, d can be found. Further, $l/2h = \tan \theta$, and therefore l and d are known. If h and r and also h and the ratio d/l are plotted for these two cases above, the curves in Figs. 5 and 6 are obtained, and some interesting and striking facts immediately arise.




ILLUMINATION VALUES ARE FOR HORIZONTAL MID SPAN FOOT CANDLES.

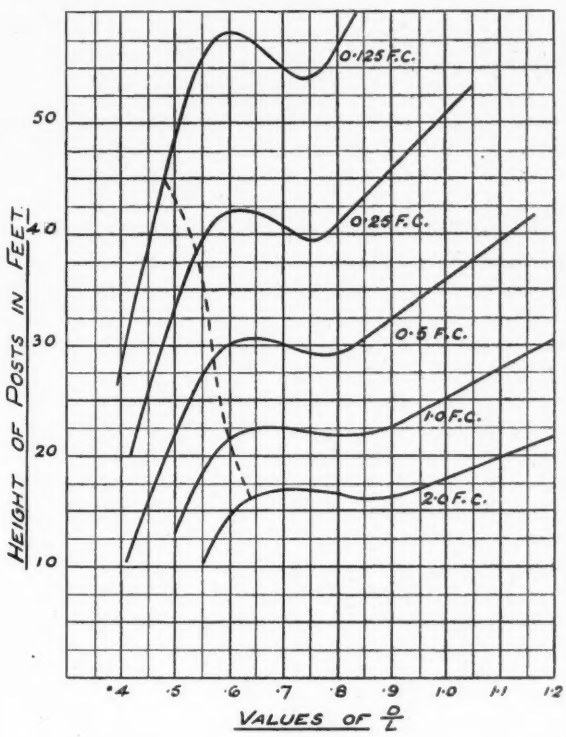
FIG. 5

The first of these is that as the curves are of cubic form, if the middle portion is considered, for any one given minimum illumination (a figure that is often specified, and that is considered later), a large variation in the ratios l/h or d/l necessitates only small changes in the height of the posts; further, that this range is practically independent of the actual value of the illumination. Now it is the height of the post which affects the absolute value of the illumination along the span, and one point which immediately appears from these curves is that between certain well-defined limits, the focussing of the lamp is not of such great importance, the tolerance in the angle $\theta_{max.}$ being in the two cases under review:—

Symmetrical ..... $70 \pm 9$ deg.
Asymmetrical ..... $80 \pm 2{\cdot}5$ ,,

The next point of note is that outside these tolerances there is a rapid variation of h with l/h or d/l, where the position of the light source is of the greatest importance, and this therefore at once provides manufacturers with a clue to the mechanical tolerances required on focussing devices in general.

It is now apparent why, if it be specified that the maximum candle-power shall be directed to any one point in the span, and the minimum illumination be also fixed, that all the other variables are also defined, including the height, span and diversity factor.




ILLUMINATION VALUES ARE FOR HORIZONTAL MID SPAN FOOT CANDLES.

FIG. 6

One more important point arising out of this simple analysis is the danger of too lightly fixing any one variable, as it is most probable that by so doing highly undesirable features may be introduced at the same time.

The curves in Figs. 5 and 6 are unexpected in shape, and it is instructive to investigate the reason for their cubic character. In the first place, it will be found that if a polar curve is employed which is uniform in shape, as, for example, in the form of a semi-circle or triangle, the function may be either double or single valued, and the kink disappears. But, on the other hand, most correctly designed street lighting fittings will exhibit a polar distribution which results in this particular shape. This is a very strong argument for the use of directive lighting in all cases of street lighting where scientific principles are employed.

Further it will be noted that the location of the maxima and minima is such as to vary in position along the axis of X as the mid span illumination varies.

It appears to be the coming practice in all cases of street lighting to take illumination values on the ground level, and if this is done in this case a considerable simplification in these characteristic curves arises.

If this simplification is effected in Fig. 2, A′ B′ C′ becomes the ground level, and the angle $\beta = \phi$ and $h = h'$. As stated above, the most important factor is in the position of the maxima and minima values of the cubic curves. With this simplification, instead of tending to cant over to the right or left, they now appear immediately over each other, so that one curve is characteristic in shape of all the others.

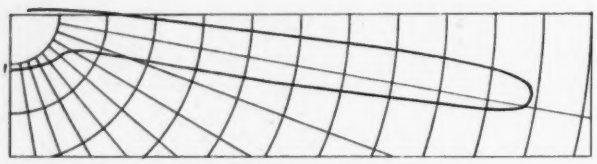
Now complete the characteristic curves as they will be finally employed in practical design, and to this end consider four different varieties of polar distributions. In Figs. 4 and 7, curves I. II., III. and IV., four such classes are represented, under the general headings:—

I.—An asymmetric fitting employing two plane mirrors and a parabolic reflector.

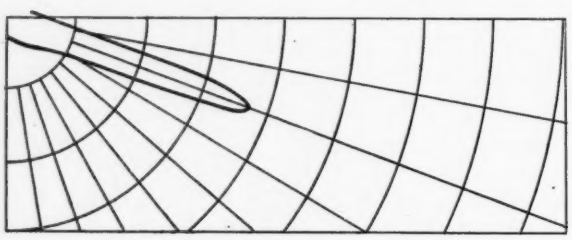
II.—An asymmetric fitting consisting of a completely enclosing prismatic bowl.

III.—A symmetric fitting with prismatic dome refractor.

IV.—A symmetric fitting with completely enclosing bowl.



POLAR CURVE OF FITTING No. II
ASYMMETRICAL (two way) WITH BOWL REFRACTOR.



POLAR CURVE OF FITTING No. IV
SYMMETRICAL WITH BOWL REFRACTOR.

FIG. 7.

In Fig. 8 one characteristic curve is drawn for each fitting, the horizontal mid span illumination being assumed to be one foot-candle, for the sake of argument, and it will be apparent that in the case of curve II. the slope of the curve is such as to make it difficult to analyse it with sufficient accuracy, and a second curve has been drawn for a mid span illumination of 0·1 foot-candles. Further, it is to be remembered that it may not be practicable to employ 1,000-watt lamps in all of these fittings, but that for comparison this has been assumed to be possible.

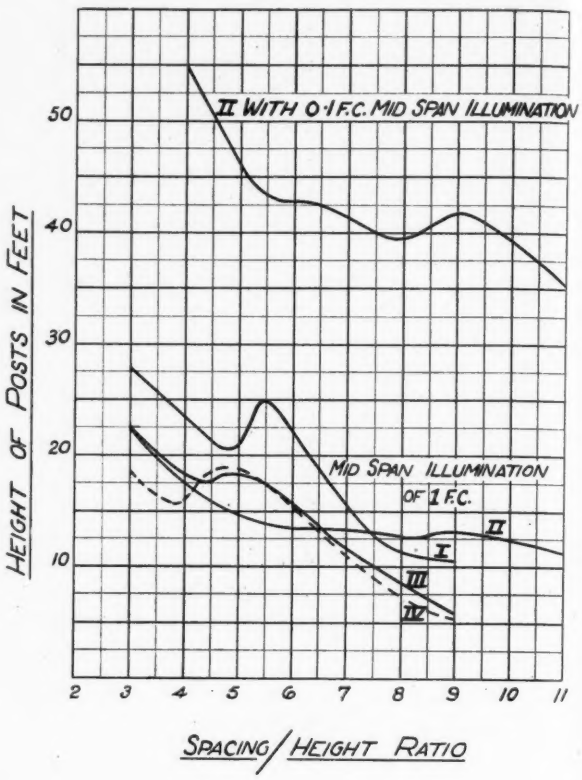
*Method of Specifying Street Lighting Data.*—All that has transpired has so far been a preface to a suggested method of specifying scientific street lighting installations, and the preliminaries have been laboured at the risk of boring the reader, in order that the main idea may be quite clear.

The number of variables involved has been mentioned and a relation established between them; but no attempt has been made to assign a numerical value to any of them for any particular street or to lay down a method by which the best result can be attained. In the past it has rested with the Public Lighting Engineer or the Illuminating Engineer to determine the illumination, and position and height of the posts according to his personal predilections. Thus it is considered that any method which assists in laying down a firm foundation for any design based on well-defined principles is worth developing and extended trial.

Firstly consider the possible criteria of satisfaction or efficiency as laid down by various expert opinions at the present time. They have been quoted above, and tabulated (*a*) to (*l*), and are now discussed in greater detail:—

(*a*) *Height of the Light Source.*—It is at once agreed that the post height is of great importance, and it should be as great as possible. Nevertheless it is obvious that in itself it is no criterion of excellence.

(*b*) *Spacing/Height Ratio.*—It has been shown in the foregoing analysis that the best ratio varies from one polar distribution to another, and therefore *à priori* it cannot be accepted as a performance gauge.




CURVES FOR 4 FITTINGS CONNECTING $\frac{s}{h}$ & $h$
ALLOWING 1000 WATT LAMP ON EACH OF TWO POSTS AND WITH A MID SPAN ILLUMINATION OF 1 FOOT CANDLE.

FIG. 8.

(*c*) *Polar Distribution.*—Again polar diagrams vary considerably, and unless the spacing/height ratio is fixed would not provide the requisite illumination.

(*d*) *Diversity Factor* is a ratio, and as such cannot specify an absolute value of illumination.

(*e*) *The Horizontal Illumination* (mid span value) is discussed below, and is recommended as the best criterion of excellence.

(*f*) and (*g*).—There is usually little difference, at any rate at small angles, between *direct and vertical illumination*, and they are therefore both considered under one heading. It is claimed by some that a high figure for the vertical illumination is necessary, as obstacles are thrown into relief, and become visible solely on account of their vertical or direct illumination. Theoretically no doubt this is true, but theory must always be tempered with the results of practical experience, and theoretically the vertical illumination immediately underneath a post is zero, the only light coming from an adjacent source; whilst the direct illumination is equal to the horizontal. The practical point is, and this cannot be too highly stressed, that if the mid span horizontal illumination is designed to be a reasonable value, then from equation (5) it is at once apparent that if $\theta$ is large (say 70 deg), then the vertical illumination must be at least $2\frac{1}{2}$ times greater than the horizontal, and the requirement of those who are the protagonists of vertical illumination alone is much better met by fixing a good minimum horizontal than by any other means.

(*h*) *The Direction of the Maximum Candle-power.*—There is no doubt that this point is of importance, but it follows naturally from a fixing of the spacing/height ratio and the polar curve, neither of which are of fundamental importance.

(*l*) and (*j*). *The Lumens Output and the Watts Input.*—These two quantities are factors which affect overall efficiency rather than good lighting, and neither can be expected to be accepted as criteria of excellence.

(*k*) *The Span.*—This is a variable, which is always a source of contention. In new installations it is possible (within limits) to choose the best span for the design; excepting only in so far as the cost is prohibitive. On the other hand, in converted installations it is often necessary to make use of existing posts and the span has to be subservient to other considerations. In such cases, which must obviously be reckoned with as possibilities, there is only one course open to the Public Lighting Engineer—he must fix his standard of horizontal illumination, and then choose a fitting from makers' catalogues which will fit in with his existing plant. He has a small variable at his disposal, viz., the height of his post, but usually this is to a large extent settled by other conditions.

When the purposes for which street lighting is required are considered, it would appear that of all of the above possibilities the one of mid span horizontal illumination, which in most cases will be approximately the minimum illumination on the street, is the one which best determines the overall quality of the lighting. It is admitted that in some instances the vertical illumination is of greater importance than the horizontal, but with some the fetish of vertical illumination is such as to obscure the fact that in practical lighting schemes it is not possible to obtain horizontal lighting and no vertical; the light distribution and reflections from neighbouring objects—houses, streets, etc.—are such as to more or less equalize matters; this point is elaborated below.

Minimum horizontal illumination must therefore specify the minimum excellence which must be exceeded at other parts of the span, and in what follows it is assumed that Public Lighting Engineers will specify a particular minimum illumination for any particular class of street. It then rests with them to choose a fitting which will provide them with this requirement.

Turn now to a consideration of Fig. 6 connecting h and d/l. It is apparent that the kink provides a stabilized performance as regards the height of post for varying values of d/l. If the mean value of d/l for this stable portion of the curve is assumed and a similar value taken for l/h in Fig. 5 and they are multiplied together,

$$\frac{d}{l} \times \frac{l}{h} = \tan \theta_{max.}$$

the value of $\tan \theta_{max.}$ will be found to be such that the calculated value of $\theta_{max.}$ equals the value as measured from the polar curve, or in other words, the mean stable values of d/l and l/h multiplied together result in a value of $\tan \theta_{max.}$ which we know to be right, and thus there is confirmation of the suggestion that this mean is based on a sound principle..

Let us now turn to a consideration of the characteristic curves in Fig. 8, and for the time being confine our attention to the characteristic for Fitting No. 1. It is apparent that the kink practically results in a reasonably constant value of the height of post for a variation in spacing height ratio of from 4·1 to 6·1 and thus the mean of these two extremes, viz., 5·1, if accepted as the correct figure would provide a useful tolerance for the ratio. At the same time this position of the curve represents a more stabilized state of affairs as regards the connection between height and spacing height ratio. If the spacing height ratio for the other fittings is calculated in a similar fashion the values for the ratios will be as shown in the table in Fig. 9. Furthermore, it will be apparent that these figures are of the same order as would be expected from a consideration of the polar curves given in Figs. 4 and 7. Thus there would appear to be a definite reason why this method should receive careful consideration, and if it is subsequently found to be correct, a method has been evolved which will enable the best spacing/height ratio to be directly calculated from the polar distribution curve.

In passing it should be noted that the angle $\theta_{max.}$ at which the maximum candle-power occurs can be read from the polar curve and hence from equation (1) the value of $\frac{d}{l}$ or the point along the curve at which this candle-power should be directed is obtained.

Having definitely fixed the spacing height ratio, the angle $\phi$ subtended at the centre point of the span can be ascertained from the simple equation,

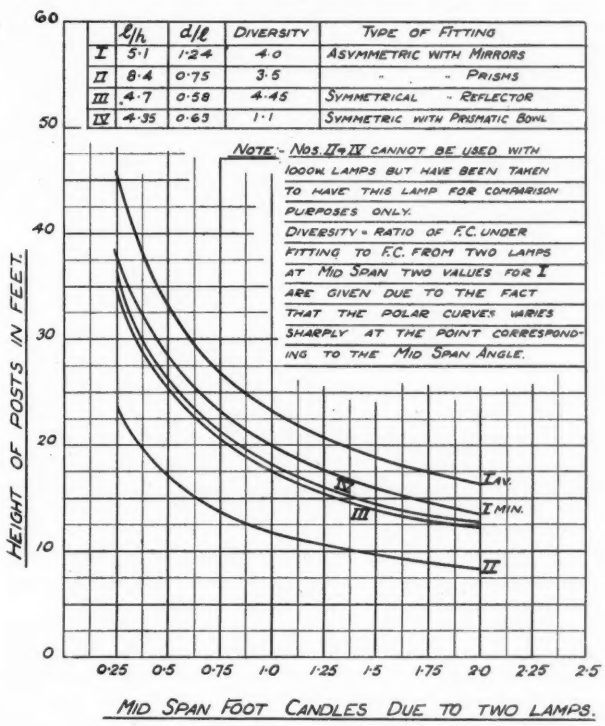
$$\tan \phi = \frac{l}{2h}$$

and further, $I\phi$ the candle-power in this direction can be read from the polar curve. Turning to equation 9,

$$L_c = \frac{2I_\phi \cos^3 \phi}{h^2}$$

$2I\phi \cos^3 \phi$ is known for the particular fitting, and therefore the relation between $L_c$ and h follows an inverse parabolic curve which is given in Fig. 9 for the four classes of fitting under review.

One word of explanation which has previously been referred to is necessary at this point with regard to the topmost curve in Fig. 8. In the bottom of curve of II.,




RELATION BETWEEN MINIMUM TOTAL ILLUMINATION AT MID SPAN ON GROUND LEVEL AND HEIGHT OF POSTS IN FEET FOR VARIOUS FITTINGS. EACH CASE REDUCED TO A STANDARD LAMP OF 1000 WATTS.

FIG. 9.

the curvature is so slight as to make the calculation of the best average spacing/height ratio difficult, and the characteristic was therefore drawn for a lower mid span illumination. The method of arriving at the ratio was by deciding on a horizontal line of symmetry (in the case of the higher No. II. curve the horizontal line at a height corresponding to 40·5 feet). The limits where this line cuts the curve occur at 9·6 and 7·2, the average of which is 8·4.

The diversity factor, which has been taken to be the ratio of horizontal illumination immediately under the post (due to one lamp) to the mid span illumination (due to two lamps) is

$$\frac{I_v}{h^2} \times \frac{h^2}{2I_\phi \cos^3 \phi} = \frac{I_v}{I_\phi} \times \tfrac{1}{2} \left(1 + \frac{r^2}{4}\right)^{\frac{3}{2}}$$

and is obviously constant once the spacing height ratio and polar curve are fixed. These factors are also given in the table attached to Fig. 9.

Lastly, since

$$\tan \phi = \frac{1}{2h}$$

and h has been calculated from Fig. 8, the illumination having been decided by the engineer, the span also is obtained.

Thus by a logical sequence of events all the variables have been definitely settled with the one assumption, viz., that the method proves to have been based on a sure foundation. This can only be finally decided by trial, and it is in the hope that practical experiments on these lines will be forthcoming that the scheme has been developed at such length.

It may be advanced, and rightly, that the curves in Fig. 9 indicate that with an increasing illumination the height of the light source will be decreased, and on the face of it this criticism is warranted. The reply, however, is that street lighting fittings must be classified under watt rating categories. Thus it is possible that these illumination curves will not extend over the whole range indicated, but that the portion up to 0·5 foot-candles will be met by lower wattage lamps, and that over 1·0 foot-candles 1,500 watt lamps will be employed, so as to decrease the height of the post in the former case and raise it in the latter. Indeed such a procedure is essential, and it would therefore appear that manufacturers who will prepare the characteristics of Fig. 8 themselves, from which they will calculate the curves of Fig. 9, will then classify their fittings under some such hypothetical headings as shown in the table.

FITTING TYPE NO. X.

| Watts. | Foot-candles (mid span). |
|---|---|
| 200 | 0·01 to 0·1 |
| 500 | 0·1 to 0·5 |
| 1000 | 0·5 to 1·25 |
| 1500 | 1·25 to 1·5 |

The process therefore by which the Engineer would be enabled to design his installation would be as follows:—

(*a*) The street he wished to light would receive a classification from which the requisite mid span illumination could at once be ascertained from a standardized table yet to be prepared.

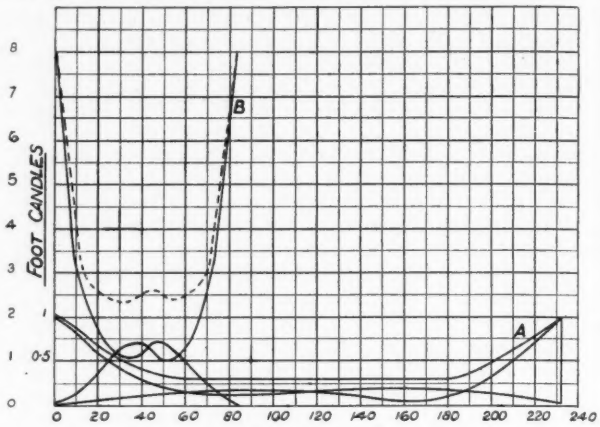
(*b*) From the various makers' catalogues he would be able to select a series of fittings together with their watt ratings in accordance with the above table.

(*c*) This would at once specify in each case the spacing/height ratio and diversity factor, and from the makers' curves in Fig. 9 the height of post would be scaled off and the span calculated.

Thus the whole problem of design would be reduced to a relatively few minutes' work and reliable result obtained.

*Horizontal Illumination Curves.*

The curves of horizontal illumination which from time to time appear in catalogues and articles in the press and which will probably be no longer required as criteria are not often correlated with spacing or height, and it is interesting to note the effect of keeping the spacing/height ratio constant as is suggested by the analysis above, and varying the height and therefore the span at the same time. In Fig. 10 this has been done for No. 1 fitting where the spacing/height ratio is taken to be 5·1, and the heights are chosen as the maximum and minimum limits of curve 1 in Fig. 8. These curves are not therefore to be supposed to be representative of any particular distribution, but to show in an exaggerated form the result of keeping the spacing/height ratio constant whilst varying the height. Thus the form of the curves is the same and the diversity factor is the same, but there is an interesting point which is at once apparent, viz., that there is an increase in peakiness of the curves with the higher values of illumination. There is a direct confirmation of the fact that this is as it should be from physiological reasons. For example, if a white screen is illuminated in such a way that the intensity varies from 40 to 4 foot-candles it can be said that the illumination is reasonably even. But if the illumination varies from ·5 to ·05, by no stretch of imagination could it be said that such was the case. The result from the practical point of view is that for low illuminations whilst the ratio of maximum to minimum foot-candles must be the same as for higher illuminations, yet the difference between the maximum and minimum values is very different in the two cases, and moreover the diversity factor can within reasonable limits be controlled.




ILLUMINATION CURVES FOR FITTING No.1 AT CONSTANT SPACING HEIGHT RATIOS BUT DIFFERENT HEIGHTS

FIG. 10.

It is interesting to note that similar conclusions to those above were arrived at by the Joint Committee on Street Lighting appointed by various societies in 1913. This Committee is so far as the writer is aware the only authoritative body which has been able to arrive at a definite conclusion on the subject, and although the minimum illuminations specified in those days were much lower than one would expect nowadays, yet it is significant that the general conclusion was one which is gaining ground at the present time.

*Asymmetric and Symmetric Distribution.*

It is with a certain amount of diffidence that this point is discussed at all at this juncture, as the time does not seem to be ripe for any definite pronouncement as to whether the one or the other system is right or wrong.

So far, however, as obvious facts point a moral, the following conclusions can be laid down:—

(1) As would be expected in the table attached to Fig. 9, the asymmetric fittings have a higher spacing/height ratio than the symmetric type, and it follows that for a given height less fittings are required per mile with the former, and thus a less overall consumption in watts and first cost. But the analysis also shows that the saving is not so great as some would lead us to expect.

(2) This saving in watts expended cannot be obtained for nothing, and it is obvious that the reduction is obtained at the expense of the side illumination.

(3) In the case of highway (country road) lighting, and where only a narrow strip of causeway, as for instance a pier or sea front, is to be lit, it is obvious that asymmetric lighting is the only economical method.

(4) In the other cases of normal suburban streets it is by no means so certain that the lack of illumination on the houses and side-walks is warranted by the saving in cost. This side of the problem must largely be decided by the local authorities and police, and left to solve itself as the future requirements dictate.

(5) It is claimed by the opponents of asymmetric lighting that glare is a determining factor in retaining the symmetric fitting in spite of all opposition from its new rival. This point must be considered later, but it is certain that it provides the most difficult argument to counter.

Thus one would hesitate before giving an opinion that one type will supersede the other. Both are needed at the present time, and with the big strides that street-lighting schemes are making it is hoped that the local authorities and police will give the matter their urgent attention, and try and aid the Engineer in his search after truth.

# POPULAR & TRADE SECTION

COMPRISING

**Installation Topics—Hygiene and Safety—Data for Contractors—Hints to Consumers**

## Some Notes on Electric Lamps

### No. 6

### THE GASFILLED LAMP

By W. J. JONES, B.Sc., A.M.I.E.E.

*(E.L.M.A. Lighting Service Bureau).*

IT is a well-known fact that the higher the temperature at which the filament of a lamp is operated the whiter the character of the light and the greater the output in candle-power. Actually a few degrees increase in temperature of the filament will produce a large increase in the amount of light which is emitted. A hot filament behaves in a somewhat similar manner to water. Even at comparatively low temperatures the filament evaporates, and the higher the temperature at which the filament is run the greater the degree of evaporation. This disintegration of the filament has the effect of producing a black deposit on the bulb of the lamp and hence reducing its efficiency, and also of bringing about a reduction in the diameter of the filament, which again produces a reduction in the efficiency.

The great problem which lamp manufacturers have had is that of reducing the tendency to blacken, and Irving Langmuir in 1913 introduced a new method of reducing this objectionable tendency after much patient research into the causes of blackening in the ordinary vacuum tungsten lamp. He came to the conclusion that all improvement of the efficiency of the electric lamp was dependent upon reducing the rate of evaporation of the filament and preventing the deposit from blackening the bulb. He introduced an inert gas into the bulb of the lamp, which had been previously carefully evacuated. The introduction, however, of the gas into the bulb causes an obvious cooling of the filament, since a considerable amount of heat is taken off by convection, but Langmuir found that the rate of dissipation of heat depended upon the diameter of the filament, and in an ingenious way reduced the effective surface of the filament, for convection purposes, by spiralizing. It was found that the spiralized filament when losing heat by convection acted very much as though it were a solid conductor the diameter of the spiral.

It will now be seen that the effect of introducing gas into a bulb is to reduce the tendency to blacken, so that for a given life the temperature at which the filament can be operated can be increased, with the consequent greater output in luminous flux. On the other hand, the introduction of the gas produces a loss of energy due to convection, and the improvement of efficiency is therefore a race between these two factors; and in practice the effect of increase in the temperature easily wins the race. It is for this reason that the gasfilled lamp is more efficient than the vacuum lamp.

Some attempt has been made by various people to manufacture lamps, for ordinary purposes, with spiralized filaments, without introducing an inert gas, and it will be obvious from the above that any attempt to increase the efficiency of lamps of this kind is attendant with blackening and short life. As to whether a lamp is gasfilled or not can always be roughly checked by feeling whether the bulb of the lamp gets hot. In the case of the gasfilled lamp the bulb temperature is considerable, while the lamp which is not gasfilled remains comparatively cool.

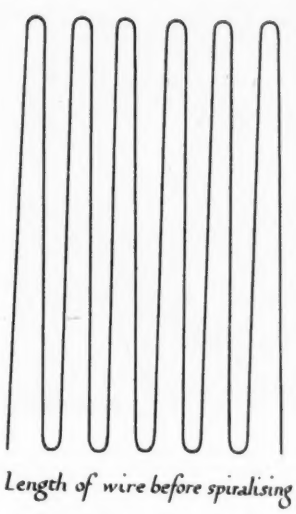



FIG. 1.—Showing relative dimensions of wire before spiralizing and when spiralized.

There are some lamps which are sold under the name of half watt type, which, in general, are not gasfilled, and the above simple procedure will check whether the lamp is gasfilled or no. Fig. 1 shows the relative dimensions of the wire which is used in the gasfilled lamp before spiralizing and when spiralized. It will be observed how enormously the filament is concentrated in the process of spiralizing.

## Popularizing School Lighting

Two popular drafts of the "Code of Lighting School Buildings" have recently been prepared and published under the joint sponsorship of the Illuminating Engineering Society (U.S.A.) and the American Institute of Architects. One is entitled "School Lighting as a Factor in Saving Sight"; the other, "Lighting the Schoolroom," is intended mainly for teachers. Of the latter, something like 50,000 copies have been distributed, chiefly amongst teachers in American schools.

# Daylight Reflections

THE problem of how to eliminate daylight reflections in shop windows is one that must have worried many a shopkeeper who appreciated the value of a well-contrived window. He may have spent much money in the construction and maintenance of his shop front only to find that so far as his windows are concerned a large percentage of it has been wasted. The very agent which was to serve him has turned traitor and seems to take delight in nullifying his most elaborate efforts to display his wares to their best advantage. Instead of an ally, daylight has become an enemy—and in some cases, a very potent enemy.

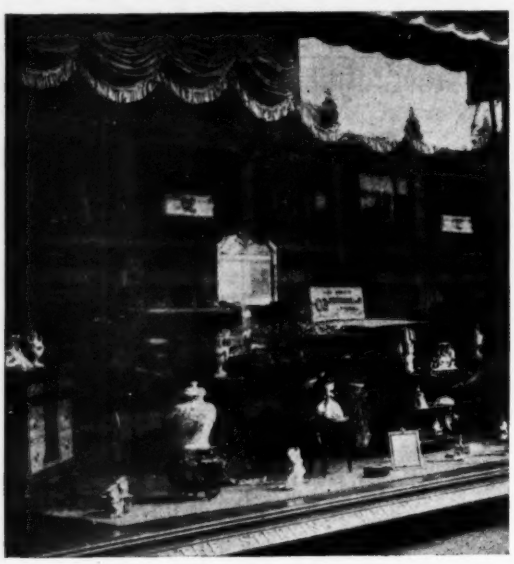


FIG. 1.—The reflected image of bright objects on the other side of the road are very prominent in this display.

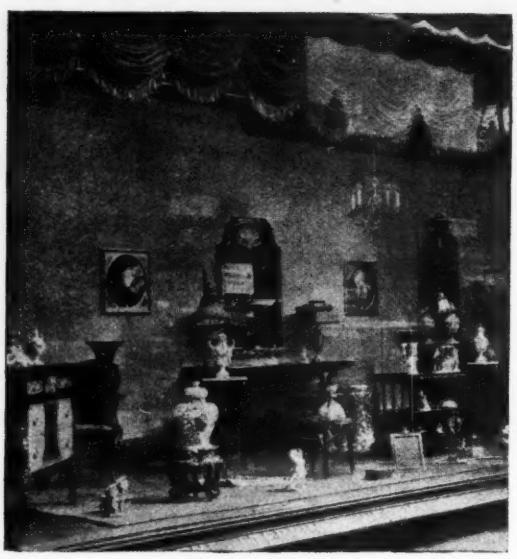


FIG. 2.—Showing how the images seen in Fig. 1 were practically eliminated by using 200 foot-candles of artificial lighting.

In its essence the problem is the same as that confronting the architect who designs a picture gallery where the pictures are shielded from dirt by means of glass covers. In this case, however, the solution, though far from simple, is considerably less difficult of attainment since the elements of the problem lie more within the control of the architect concerned than they do in the matter of shop windows. By means of suitably designed roofing and screens he is able to control direct and reflected light in a way quite beyond the reach of the man who deals with window reflections.

In both cases the aim is to make as much daylight as possible penetrate the glass and reach the object displayed, and to eliminate, as far as possible, all those rays which are reflected back at the surface of the glass into the observer's eyes. Evidently, therefore, he may do one or both of two things. He may so construct his window that reflected light is sent downwards to the ground or somewhere beneath the observer's line of vision, or he may increase the intensity of illumination on the object from behind the glass.

In certain instances the first method has been adopted. A window has been designed that curves inwards towards the exhibits as it descends towards the pavement. This has proved effective, but has the disadvantage of thrusting the displayed goods some two feet farther back into the shop, thus giving a sense of distance to the observer, and at the same time diminishing the natural light falling on the objects.

The other device, namely that of intensifying the light that falls on the goods, has been adopted in several instances with very satisfactory results. An illustration of this is provided above. In Fig. 1 the window of a bric-a-brac shop is shown in which the illumination is normal daylight. As will be seen, the whole effect of the display is ruined by reflections of objects outside the shop. The building opposite, together with motor-cars, tramcars and passers-by, are all mixed in the picture, and make it almost impossible to examine the vases, etc., that it is intended to exhibit. The next illustration, however, shows the result of using suitably adjusted flood-light projectors, whose beams are directed on to the objects in order to raise their intensity of illumination above that of the reflection at the surface of the glass. Here the vases stand out clearly, and the troublesome reflections are no longer apparent to the eye.

The intensity of illumination in such cases must, of course, be high. This means that the light employed must be concentrated on to a small area. Naturally this tends towards a somewhat heavy consumption of electrical energy, and for that reason many shopkeepers show reluctance to employ it. Nevertheless, even if the cost were much above what it actually is, the result would amply justify this expenditure, since it enables the window, which would otherwise be costly and well-nigh useless, to become what it is intended to be, the finest advertisement that a shopkeeper can employ.

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## Personal Note

We record with pleasure the baronetcy which has been conferred on Sir Hugo Hirst, whose long-standing association with the electrical industry is known to all our readers. Sir Hugo, the Chairman of the General Electric Co., Ltd., has been responsible for many important advances by this firm in connection with lighting. The original Osram works were founded early in the history of the electric incandescent lamp, when the patents of Edison and Swan expired in 1892, and the Company has kept pace with each successive development. The factories laid down in Witton did most valuable service during the war in furnishing carbons for arc lamps and searchlights, at a time when these were only obtainable with great difficulty from abroad. The acquirement of other important engineering works has gone far to render the Company self-supporting in all sections of the electrical industry. The research laboratories at Wembley form one of the largest and best equipped in this country, and, like other advances, are to be traced largely to Sir Hugo's broad outlook and foresight. Having established its position in the manufacture of lamps and lighting appliances the Company is now taking a keen interest in illuminating engineering, and has established an organization for training employees in this field of work. It has likewise grasped the need of the age—co-operation—as illustrated by its participation and support for the E.L.M.A., and in the international developments which are now proceeding in the lighting field.

In all this we see the influence of Sir Hugo's enterprise and sagacity, and his judgment in the selection of able co-workers. We are glad that his services to industry have received appropriate recognition.

# The Local Generation of Electricity for Cinemas

THE following notes on the generation of electricity for the inside and outside lighting of cinemas and for the cinema arc are based on practical experience in a large number of cinemas in the Greater London area.

For a cinema of average size an 18 B.H.P. gas engine is frequently installed, together with a dynamo of about 10 kilowatt capacity, capable of providing sufficient current for the picture arc and the general lighting of the theatre. The average number of units consumed per annum in such a cinema would be about 21,000, and the consumption of gas per unit generated about 18,000 B.Th.U.'s. With gas at 8d. per therm, 18,000 B.Th.U.'s cost just under 1½d.

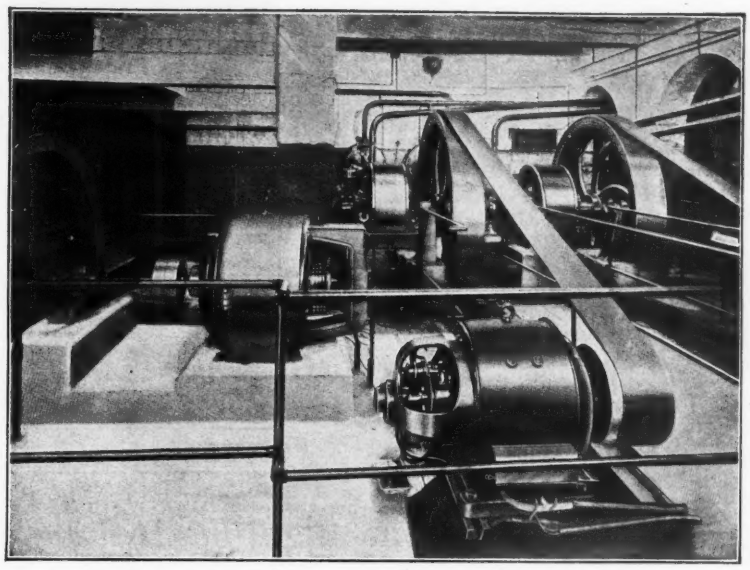


FIG. 1.—A fine installation of gas engines driving dynamos at the Pavilion Picture Palace, Marble Arch, London, where current is generated at a very low cost. The two 53·5 B.H.P. engines coupled to dynamos, to be seen on the right, generate electricity for the cinema as well as for driving the motors of a large ventilating fan, for blowing the organ and for working a vacuum carpet cleaner. The 35 B.H.P. gas engine on the left drives the dynamo which generates current for lighting the offices, for vacuum cleaners, for fans and for charging the set of accumulators, etc., before the pictures are shown.

The approximate cost of a gas-engine-driven electricity generating set would be £450, and the annual cost of generating the amount of current mentioned would, on this basis, work out as follows:—

| | | | |
|---|---|---|---|
| Gas—21,000 units at 18,000 B.Th.U. per unit equals 3,780 therms at 8d. per therm ... | £126 | 0 | 0 |
| Interest on capital outlay (5% on £450) ... | £22 | 10 | 0 |
| Depreciation (7½% on £450) ... ... ... | £33 | 15 | 0 |
| Renewals and oil (say) ... ... ... ... | £18 | 0 | 0 |
| Attendance (say) ... ... ... ... ... | £26 | 0 | 0 |
| | £226 | 5 | 0 |

For the super-cinema, a plant of about double the above size would be necessary, but the actual cost per unit generated would be approximately the same.

It will be seen from the above figures that it is possible, by using gas for generating purposes, to obtain electricity at an attractively low cost. The figures given are not quite so favourable as would usually be found to be the case in practice, for the following reasons:—

1. The current required when the gas engine and dynamo are installed would in practice be less than that required if the current were taken from the mains, as, in the latter case, part of it has to be transformed to a lower voltage, and as transforming losses amount to from 20 to 30 per cent., the current available for actual light production is therefore only 70 to 80 per cent. of the units registered on the meter in respect of that portion of the current used at the lower voltage.

2. In making the above calculations of the cost of generating, the figure included for labour is considerably higher than it would be in many cases.

The occasional attention required by the engine could easily be given by one of the attendants in addition to his ordinary duties. In all probability the offer of a small additional sum per week for carrying out this work would be gladly accepted.

Where the price of gas is more or less than the figure quoted, the above statement can easily be altered to meet the changed conditions.

The saving effected by generating electricity by gas engine for lighting cinemas could also be effected in connection with other businesses where the proprietors are large users of electricity for lighting purposes.

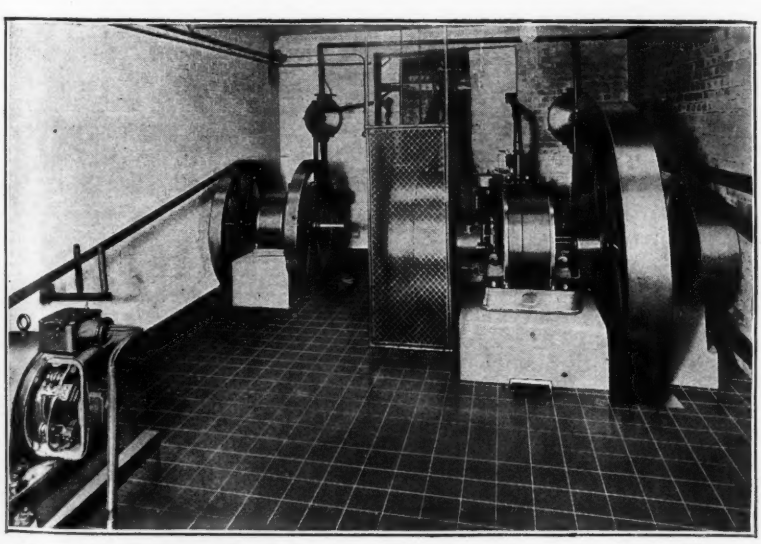


FIG 2.—The proprietors of the Prince's Picture Playhouse, Kennington Park Road, London, in a letter dated November 9th, 1923, stated that the gas engines for generating electricity had been running over ten months and had proved thoroughly reliable. They added: "The efficiency of the plant installed is proved by the fact that we are now generating at 1·16d. per unit after allowing for depreciation and repairs and a proportion of our operator's wages."

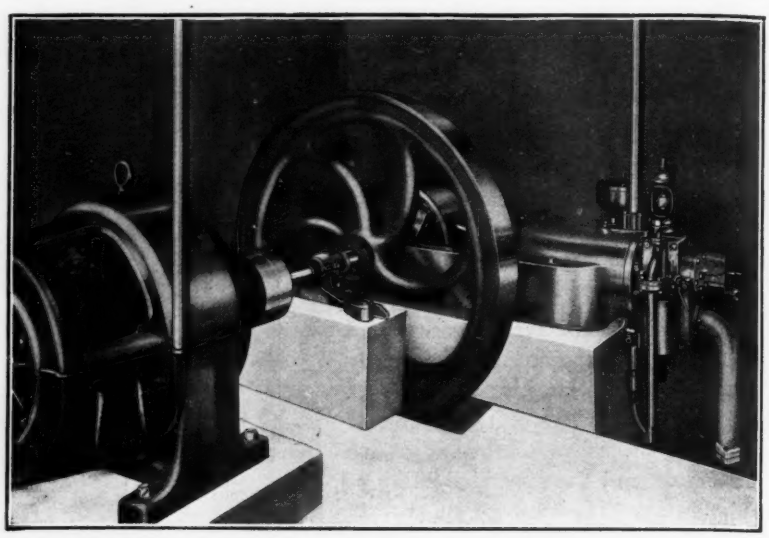


FIG. 3.—The proprietors of the Crofton Park Cinema, Brockley Road, London, state: "We are quite agreeable to your publishing the figures for the working of the gas engine supplied to us in August last.

Twelve weeks in 1923—September 3rd to November 19th: Hall 110 ft. long; showing 53 hours per week; current generated by town's gas engine and dynamo—£28 16s. 5d.

Secondary lighting from main at 6d. per unit—£9 2s. 10d.

If it continues to run as well in the future as it has done up to now we shall be more than satisfied, as it effects a very considerable saving in our working expenses."

# Model Gas Lighting Installations at Wembley

## Four of a large number of rooms in the British Empire Gas Exhibit at Wembley fitted with efficient and beautiful Incandescent Gas Lighting Fittings


FIG. 1.—Bedroom boudoir lighted by silk-shaded inverted gas burners on brackets, table standards and pendants. Some of the lights are turned on and off by operating the switch to be seen on the right of the illustration.

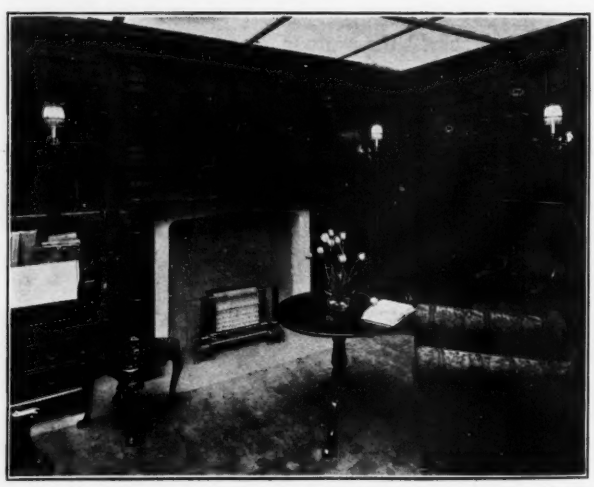


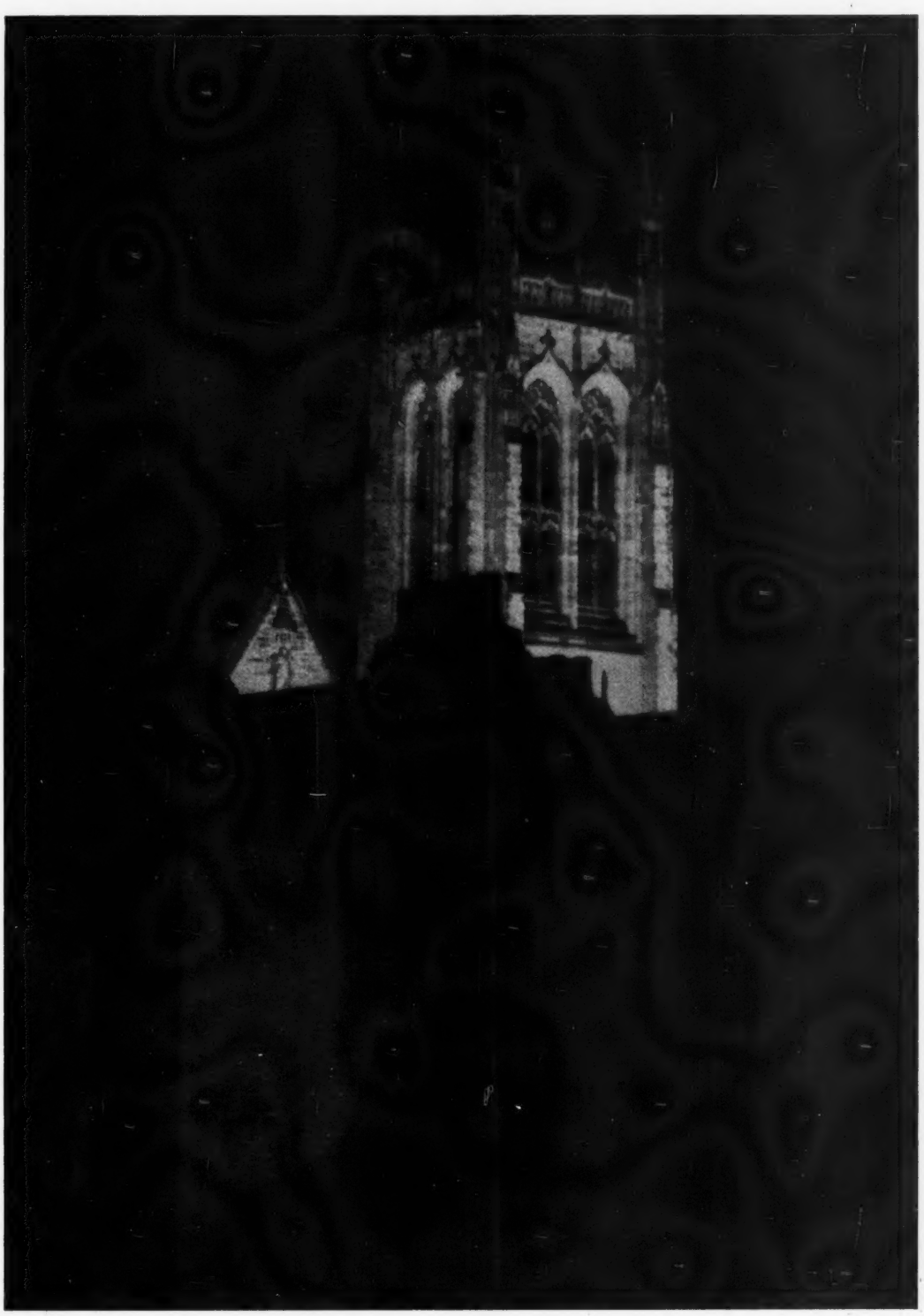
FIG. 2.—A beautiful room placed by the British Empire Gas Exhibit Committee at the Disposal of the Society of Women Journalists. The gas candle brackets are of a design which harmonizes with the panelled interior.

FIG. 3.—A well-equipped kitchen with gas and coke cooking and water-heating apparatus and inverted incandescent gas lighting fittings of simple design fitted with silica-ware shades which successfully withstand the heat from the mantle.

FIG. 4.—Model of a chauffeur's kitchen lighted by inverted incandescent gas burners on pendants. Adjoining this kitchen is a model garage fitted with wall gas lights specially designed for use in garages.

# Leamington Parish Church by Night

## An Interesting Photograph



By the courtesy of Mr. R. S. Ramsden, General Manager and Engineer of the Leamington Priors Gas Company, we are presenting the above picture of the Leamington Parish Church. This view was taken by Mr. W. Walden Hammond at night, and we understand that there was no moon, the only light available being that from the high-pressure incandescent gas lamps on the tramway standards, and from the shop windows on the Parade. The photograph recently appeared in the *Amateur Photographer,* and is of considerable technical interest. Incidentally, it shows how effects resembling "flood-lighting" may be produced by ordinary street lamps when a certain amount of light is allowed to fall on adjacent buildings.

# The National Gas Council

## Seventh Annual General Meeting

THE Annual General Meeting of the National Gas Council, followed by luncheon at the Hotel Great Central, on May 26th, was the occasion of an interesting address by the President, Mr. D. Milne Watson.

In his opening remarks, Mr. Milne Watson drew attention to the scientific and material progress of the gas industry. He pointed out that sales of gas in Great Britain had risen from 160,000 million feet in 1902 to 274,000 million feet in 1923, and the figures for 1924 would doubtless show a further expansion. But even taking the year 1923 as a basis, the increase was more than 70 per cent. This advance he believed was largely due to the work undertaken by the British Commercial Gas Association in familiarizing the public with the innumerable uses of gas.

Mr. Milne Watson then proceeded to point out how the activities of every country were primarily determined by its natural resources; a nation which endeavoured to force the growth of exotic industries would fail in its object. This led to some comments on the fuel problem, and to the proposals that have been made that future schemes of electrification should be aided by a Government subsidy. Mr. Milne Watson explained that he did not for one moment suggest that electricity does not fulfil a useful purpose in its own sphere. Thanks to the skill and energy of those engaged in that industry, these functions are admirably performed. Electrical apparatus made in this country is known for its excellence throughout the world and he believed that those engaged in its manufacture, equally with those concerned with the supply of electricity, were second to none in scientific knowledge, resourcefulness and initiative. The gas industry did not belittle the services of electricity—gas undertakings themselves employ electricity in their works—but this country's greatness was due to its natural fuel resources; and of these resources the gas industry, after an existence of over 100 years, had become the principal conservator.

Comparisons between the gas and electric industries in this and other countries were misleading. Countries having abundant water supplies but little coal were in quite a different position from Great Britain. As regards power supplies, it appeared that the cost of electricity in this country was not excessive. But in any case it did not form more than 1½ per cent. of the total manufacturing costs, so that even were power supplied for nothing this could not materially affect the industrial position. It could not be said that cheap electricity was necessarily associated with employment. France and Germany both consumed very little more energy per head than Great Britain, yet in these two countries unemployment was practically non-existent.

After discussing various proposals in connection with electrical schemes, Mr. Milne Watson contended that, if the desired centralizing schemes were beneficial, why should not the electrical industry itself undertake the work? The industry was not depressed, but had great financial resources and every facility for raising capital. Parliament could grant the necessary legislative powers for joint working or amalgamation, but the gas industry protested against the suggestion that State aid should be afforded in order to enable the electricity supply industry to put its own house in order.

Sir Arthur Duckham, Alderman F. S. Phillips and others expressed similar views, and the matter was again discussed in Mr. Ferguson Bell's address to the Institution of Gas Engineers at its annual meeting, held during June 9th-11th.

# Institution of Gas Engineers

## Annual Meeting

AN address was delivered by Sir Alfred Mond, who outlined the proposals for dealing with unemployment, and discussed their application to the gas industry. Mr. Ferguson Bell, in his presidential address, quoted many data to illustrate the growth of the gas industry, an interesting item being a diagram showing the advances in gas made, consumers and capital employed during the period 1913-24. Other statistics were given for the gas industry in America, where in 1923 a new high record was reached, viz., 370,000 million cubic feet of manufactured gas and 124,000 million cubic feet of natural gas. He drew attention to the part played by the gas industry in coal conservation and in diminishing the pollution of the atmospheres of cities by smoke, and he mentioned that the B.C.G.A. had now a list of over 4,000 trades in which gas is employed. He referred to opportunities of co-operation between gas and electricity, as illustrated by the "Sandwich" system of coke-firing for boilers. There was ample room for both gas and electricity in their own spheres. But many of those in the electrical industry were themselves doubtful whether Government financial assistance was desirable. In any case, if the Government were determined to adopt a policy of national subsidies, all rival and competitive industries should be treated alike.

Mr. F. W. Goodenough, in presenting the Report of the Advisory Committee on Education, explained the steps that were being taken to increase the number of educational centres. The number of students attending such courses showed a gratifying increase; yet the number was still very much less than it should be. The industry would need more and more educated staffs, and gas undertakings should create a demand for better human material by paying qualified men good salaries. Mr. Goodenough also defended the young man of the present day against the aspersions of a writer in *The Times*, remarking that the labour-saving machinery of modern business life had greatly increased the hourly output of nervous energy and made some periods of relaxation essential.

Interesting data are contained in a report of the Research Subcommittee on the aeration of lighting burners; one conclusion being that the degree of primary air obtained in an ordinary lighting burner, working normally and satisfactorily, is less than half that required for complete combustion.

A pleasant incident was the presentation to Dr. Charles Carpenter of the Birmingham Medal, founded as a recognition of merit by the Midland Association of Gas Engineers and Managers in 1881.

# Local Units for Industrial Lighting

FIG. 1.—Adjustable Unit for Drawing Board.

FIG. 2.—Local Lighting of Lathe.

WHILST the advantages of general lighting by overhead units is frequently emphasized, there is still something to be said for local units, especially in cases where (a) the work is very fine or the material dark in texture, requiring exceptionally high illumination, or (b) the nature of the process is such that the worker wishes to see the object by light coming from different directions, and therefore likes an adjustable unit which can be moved about, or (c) where the avoidance of certain inconvenient shadows is necessary, and may also need an adjustable unit under the worker's control.

The three illustrations accompanying this note appear in a treatise on illumination by Mr. Paul Heyck,* a leading authority on illumination in Germany. The book contains a great deal of other useful information on illumination, including a summary of the Recommendations on Illumination recently issued by the German Illuminating Engineering Society.† But we have selected these three pictures to illustrate the particular question of local lighting.

The first figure shows the application of the method to a drawing-board. Indirect general lighting for drawing offices is often recommended, and doubtless does good service if a sufficiently high illumination is obtained; the very soft shadows would appear to be an advantage; but to secure the necessary high illumination with indirect lighting is apt to involve rather a high expenditure of energy. Moreover, some draughtsmen, whilst considering five to six foot-candles sufficient for simple work, prefer a higher value when tracing is to be done, and also lay stress on the *direction* of the light, contending that diffused light, coming from many different directions, is not suitable for illuminating more or less shiny tracing paper. If, however, local lights are used, it is essential that they should be perfectly shaded, and should be fully adjustable, so as to avoid completely any shadows from the edges of drawing implements. The unit shown in Fig. 1 has considerable latitude of adjustment, and enables the draughtsman to alter the angle at which light comes so as to avoid troublesome shadows. The filament is completely screened from the draughtsman's eyes.

FIG. 3.—Local Lighting for Drill.

In the other two illustrations local units for lighting a drill and lathe are shown. In such cases adjustability is often important, and whilst good general lighting usually enables work to be done satisfactorily, there are cases in which supplementary local lighting from well-shaded units is useful. When, however, reliance is placed chiefly on local units (as is not unusual, for example, in the clothing and bootmaking industries) it is of great importance to provide moderate general lighting in addition, so as to relieve the contrast between the brightly lighted working area and dark surroundings. The illustrations here reproduced serve very well to show the advantages of local units; but with this object the surroundings seem to have been allowed to appear darker than would be desirable in actual practice.

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* "Beleuchtung," by Paul Heyck. (Dr. Max Jänecke, Leipzig, 1924.)

† See *Illuminating Engineer*, April, 1925, pp. 95-96; May, 1925, pp. 130-132.

# Some Impressions of the Lighting at the British Empire Exhibition

By A Correspondent

AT the Conference on Illuminating Engineering at the Exhibition last year there were two papers, contributed respectively by Mr. Haydn T. Harrison and by Mr. Jennings, discussing the gas and electric lighting. So far as the gas lighting in the Amusement Park is concerned, it is understood that the arrangements are substantially the same as those adopted last year. Mr. Jennings, in his paper, drew attention to the exceptionally high illumination provided, well suited to this section of the Exhibition, which is again furnished this year.

But it was generally agreed that the exterior lighting of the rest of the Exhibition, largely owing to limitations in the electric energy available, was not all that might be expected. New arrangements were accordingly made for 1925. A forecast of these improvements was given recently in this journal.*

The long period of daylight and the bright sunshine of the past few weeks have not been wholly favourable to the study of lighting conditions. Yet it may be said with truth that the Exhibition is looking at its best. The gardens have been much improved, and the play of light and colour, even in the daytime, is pleasant to witness. In the rays of the setting sun one gets glimpses of flood-lighting on a scale impossible by artificial light, and the white buildings, seen against a gradually changing sky, present pictures interesting to any illuminating engineer.

It is most interesting to sit and watch the gradual transition from daylight to artificial light; to notice how some artificial effects, at first inappreciable, become prominent as the darkness deepens. But it may be questioned whether the effect in full darkness is superior to that in the twilight, when an amethyst sky is added to the attractions of artificial lighting.

The writer must confess to a preference for concealed lighting effects, even if subdued. But it is evident that in exhibition lighting one must consider the impressions of the public. Thus whilst one would personally have preferred the bridges on the ornamental lake to be illuminated only by concealed sources, one must recognize that the system of studding them with lamps is accepted by the parties in boats with satisfaction. Similarly the outlining of buildings with glow lamps, a familiar feature of previous exhibitions, appeals to the public. There is, moreover, one important distinction to be noted—the general use of colour-sprayed lamps with diffusing bulbs. There can be no doubt that the use of these lamps, especially with the white walls of buildings as a background, is much less open to criticism than the clear bulb lamps of former days. Thus the masses of golden lamps on columns which supplement the lighting of the main avenue leading to the Stadium, and produce quite a brilliant effect, would surely have been intolerable had bare lamps been used. In this thoroughfare the impression of brightness has been much accentuated as compared with last year. The illumination of faces of adjacent buildings with mauve and violet light from concealed sources is another welcome innovation, though one feels that it is somewhat masked by the brightness of the adjacent clusters of golden lamps.

Of the flood-lighting of the main Government buildings a clearer view is obtainable, and in complete darkness they stand out well. In the writer's opinion, quite one of the most successful of these effects is the view of "India," with its contrast of green walls and rose-coloured light seen through the arches; but at the other extremity of the lake the flood-lighting of two minarets with coloured light is also quite spectacular.

The writer had looked forward with interest to the illuminated creatures used on the lake, which he had seen in course of construction. These may fairly be described as amongst the most novel devices adopted since last year, and they have doubtless added to the popularity of trips on the water. This was, of course, in the nature of an experiment. Perhaps the sense of reality would have been greater if the interior illumination had been less bright. In some cases "creatures" were operated by a flasher, and it is difficult to believe in flashing squirrels! The famous serpent in the Garden of Eden would, one thought, have been more impressive had the brightness been more even; one could not resist the impression that it had swallowed a number of lamps, which had "stuck" in its interior at intervals. At the same time, one must own that he, like the crocodile, was a first favourite with the party in the boat used by the writer; his own preference was for the swans and ducks, in which the "works" are less evident. For the rest, the illuminated fruits on the trees showed up well. Taken as a whole, these illuminated devices have doubtless captured the imagination of visitors. Amongst other novelties should be mentioned the display of coloured search-lights, and the luminous pillars composed of neon tubing. One of the latter is a very prominent object in the courtyard as one enters the Exhibition. Some of the effects of coloured light on foliage are also pleasing, though occasionally the eye finds a difficulty in separating them from adjacent objects that are relatively bright in comparison.

Whilst, therefore, one is still conscious of the lack of a concerted scheme in the lighting of this section of the Exhibition, it may be said that the impression of insufficient light has been largely removed, and that from the popular standpoint, the Exhibition has been made a more attractive place by night—especially in the present real summer weather. To the eye of the expert and the artist the combination of clusters of lamps and rows of lamps, even of the sprayed type, with flood-lighting, has naturally some drawbacks. The conventional bright lighting associated with former exhibitions is apt to mask the effect of the more delicate flood-lighting. The reconciliation of these two aims, the provision of bright, festive illumination and the display of charming but somewhat subdued colour-contrasts, is one of the chief problems. Perhaps in the future it might be better to specialize in these two methods in different sections of the Exhibition.

* *Illuminating Engineer*, March, 1925, p. 59.

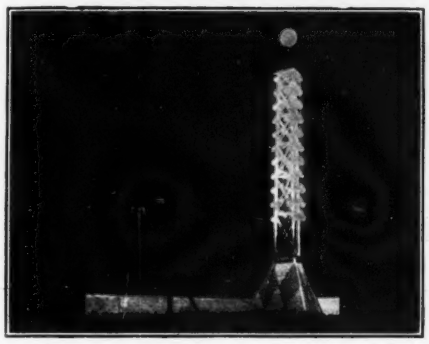

FIG. 1.—The illuminated column for guiding aeroplanes.

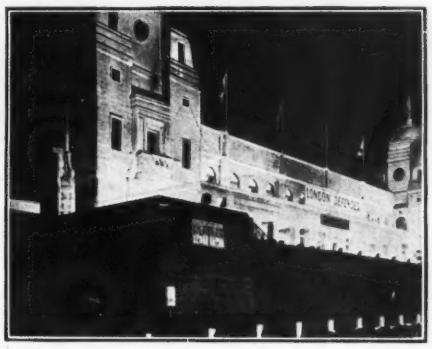

FIG. 2.—The front of the Stadium flood-lighted at night

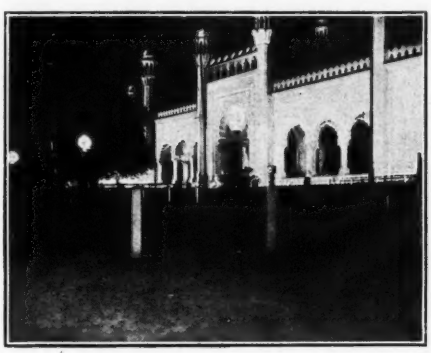

FIG. 3.—The front of India as it appears by night.

FIG. 4.—Treasure Island.

# Electric Lighting at Wembley

For the above four illustrations of special methods of lighting at the British Empire Exhibition we are indebted to the General Electric Co., Ltd.

The first illustration shows the illuminated column for the guidance of aeroplanes, whilst Fig. 2 shows a view of the flood-lighting of the front of the Stadium. The projectors for this purpose each utilize a 1,000 candle-power watt Osram gasfilled lamp. The third illustration likewise depicts flood-lighting. On the top of the walls of the courtyard facing the main building a number of flood-light projectors are mounted, equipped with red colour screens. Red light is thus projected upon the white surfaces and then is reflected upon the walls of the courtyard, thus giving well-diffused rose-coloured illumination.

The contrast of red and green surfaces illuminated furnished by this building is quite striking, especially when viewed from the lake. Indeed, many people would consider this one of the most effective bits of exterior lighting in the Exhibition.

The remaining illustration relates to "Treasure Island," one of the novelties of the 1925 Exhibition, easily reached from Old London Bridge and much appreciated by the young people. The island, it may be recalled, stands in the centre of a lake with sandy shore. Its caverns are illuminated by some hundreds of blue colour-sprayed lamps, whilst on the top of the rock in the centre of the island is a mammoth candle and candlestick outlined in white Osram lamps and surmounted by an illuminated flambeaux shade; viewed from the shore the interior of the caverns, illuminated by blue light, presents quite a spectacular appearance.

# TRADE NOTES & ANNOUNCEMENTS

## METRO-VICK SUPPLIES.

In our last issue we referred to the series of recent catalogues sent us by Messrs. Metro-Vick Supplies, Ltd., and we take the opportunity to add a few words on them individually. Of recent years enclosed diffusing glassware has become popular, and the "Moonstone" list contains a very good selection of units of this type. The introduction contains some representative polar curves and data on intensity of illumination and calculation of wattage required. We note that the tables of illumination for various interiors are given as subject to confirmation and not to be quoted as standards, which seems a judicious step.

The loose leaf catalogues devoted respectively to electrical supplies and electrical fittings are very comprehensive. There is a fully illustrated section devoted to standard and special forms of lamps, and the fittings catalogue contains some effective illustrations. The view of the "William and Mary" showroom, reproduced herewith, occurs in the Moonstone catalogue and strikes one as a good example of special treatment of a period, as the attempt has not been made to show too much. Other lists deal with Cosmos fires and radio equipment —the latter a field of which the Company has made a speciality.

Finally we may note a selection of small illustrated leaflets, of convenient pocket size, dealing with lighting, wireless, heating and other special devices. One of these is devoted to inexpensive home fittings; another ("A Light Subject") is illustrated by highly-coloured pictures showing the use of Cosmos lamps in home, office, shops, factories, etc.

## AUTOMATIC TEMPERATURE REGULATORS.

In these days temperature-regulation has become a fine art—largely due to the fact that accurate apparatus for the purpose is available. A catalogue just received from the Cambridge Scientific Instrument Co., Ltd., shows the variety of such devices for furnace work, etc. Temperature can be taken through any cycle. It may for instance be increased automatically up to a maximum, maintained at this value for a prescribed period, and the rate of subsequent cooling also controlled. In addition to control units, both electrical and mechanical, relays, valves, delayed action temperature switches and regulators for liquids in steam-heated tanks are also shown.

## ELECTRIC BLOCKS.

From S. H. Heywood & Co., Ltd., we receive a pamphlet describing the new form of "Heywood" patent "New Model" electric block. Features claimed for this include accessibility, combined protection when required, simple design and strong construction and a fool-proof system of electric braking which permits any load to be lowered under full control and makes dangerous racing impossible.

## CONTRACTS CLOSED.

The following contracts and orders are announced :—

MESSRS. SIEMENS and ENGLISH ELECTRIC LAMP CO., LTD. :

*London County Council*, contract for the whole of their requirements in electric incandescent lamps for a period of twelve months.

*London Midland and Scottish Railway*, contract for a large quantity of vacuum lamps for train lighting.

MESSRS. THE GENERAL ELECTRIC CO., LTD. :

*London Midland and Scottish Railway*, contract for the supply of 5,000 20 v. 155 watt Osram vacuum train-lighting lamps.

MESSRS THE D.P. BATTERY CO., LTD. :

*Aberdeen Corporation Electricity Department*, order for standard heavy central station type plates, with capacity of 2,904 amp.-hours, for their Ferryhill Generating Station Battery.

The "William and Mary" Room at the London Showrooms of Metro-Vick Supplies, Ltd.

## INNOVATIONS IN PENCILS.

From Alpco Pencils, Ltd. (173-5, Lower Clapton Road, London), we have received a set of their special coloured pencils, a feature of which is the production of thin leads instead of the large diameters hitherto employed. These "Unique" pencils are specially recommended to draughtsmen, and the composition enables the leads to be sharpened to a fine point and prevents frequent breakage.

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## "ELECTRICITY FOR EVERYBODY."

The third and revised edition of the above publication (7/6 net) is now available from the Electrical Press, Ltd. The work is edited by Mr. R. Borlase Matthews and contains upwards of 450 pages. There are four main divisions, devoted respectively to electric lighting, electric cooking and heating, electric power, and selling electricity.

In the section on electric lighting we have first information on the advantages of electric light, costs of installation, systems of wiring, etc. Residence lighting, shop lighting and advertising by electricity, the lighting of churches, public buildings and factories are successively dealt with. There are special sections on lamps and illumination, and further information on reading meters, electro-medical apparatus, etc.

It will be seen, therefore, that this section alone covers a very wide ground. The matter is inevitably compressed, but we think that in the note on vacuum tube lamps something might be said about neon lamps, which are omitted, whereas the "vacuum tube light" described is apparently the Moore $Co_2$ lamp, little known and used in this country. The data on planning lighting installations are useful, though naturally conventional rules cannot always be followed closely. One would like to see some reference to the Home Office Departmental Committee's reports on industrial lighting.

## VERITAS HOUSE—MESSRS. FALK, STADELMANN & CO.'S NEW GLASGOW WAREHOUSE.

The accompanying illustration, lent by courtesy of the *Hardware Trade Journal*, shows a view of the exterior of the new warehouse of Messrs. Falk, Stadelmann & Co. in Glasgow, which was recently opened by Lord Provost Montgomery.

It may be recalled that the original building was destroyed by fire in September, 1922. The new premises, designed by Mr. Eric A Sutherland, now reach 110 feet above the street level. As readers are aware this firm is interested alike in gas, electric and oil lamps. Thus on entering the main doors the visitor at once finds himself in the electricity showroom, whilst on the first floor there is a gas showroom which includes a little "trying-on" room, where shades of all shapes and sizes can be tried on a lamp. The other six stories are used for stores and packing and dispatching, all material being carefully pigeon-holed and indexed.

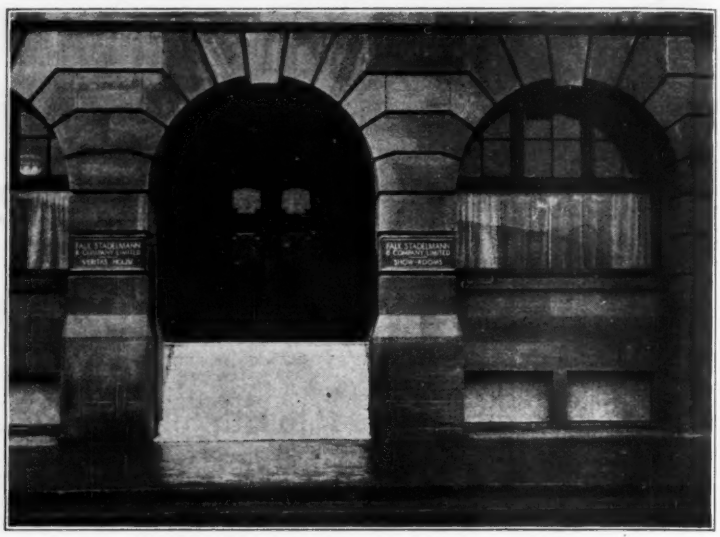


FIG. 1.—Entrance to Messrs. Falk, Stadelmann & Co.'s New Warehouse in Glasgow.

The opening ceremony was marked by an address by the Lord Provost, who recalled that although the firm was founded in 1881 the Glasgow branch was not started until 1905, so that rapid progress has been made. Others who took part in the proceedings included Mr. M'Lusky, general manager of the Glasgow Corporation Gas Department, and Mr. Mitchell, general manager of the Corporation Electricity Department, so that both illuminants were appropriately represented. Mr. Max Falk, in proposing a vote of thanks to the Provost, remarked that "light is life," so that in furnishing this commodity the firm, which now employs nearly 2,000 workers, is doing valuable public service.

## MAZDALUX INDUSTRIAL LIGHTING.

A well illustrated booklet issued by the British Thomson-Houston Co., Ltd., shows a wide range of fittings for industrial lighting. Besides illustrations and polar curves of the familiar dispersive and concentrating types, a special account is given of the new "Glassteel" units, a feature of which is the provision of apertures enabling a small proportion of light to pass upwards; another good feature is the special method of eliminating glare. Another new form of unit is the rectangular reflector, specially useful for the illumination of posters, hoardings and large vertical surfaces.

We take this opportunity of referring to the luncheon and Press view of the new Mazda House, arranged for June 25th. The visit takes place after we go to press, but we hope to give an account of the proceedings in our next number.

## HIGH TENSION HOMOGENEOUS LEADLESS CABLES.

A notice received from the Maatschappij Tot Vervaardiging van Homogene Kabels (Homogeneous Cables, Ltd.) of The Hague, draws attention to their leadless homogeneous cables insulated with "karetnja," a bitumastic material invented by Mr. Ali. Cohen, for which exceptional qualities are claimed. Apart from its good insulating properties, the material is stated to be impermeable to water, rendering lead sheathing unnecessary, and as it is itself very light, the saving in weight is very considerable. Cables so constructed are said to have been in use for 20 years or more without visible deterioration, and particulars are given of exhaustive tests at pressures up to 60,000 volts in order to illustrate the high dielectric strength.

## THE USE OF GAS IN KINEMA THEATRES AND CAFES.

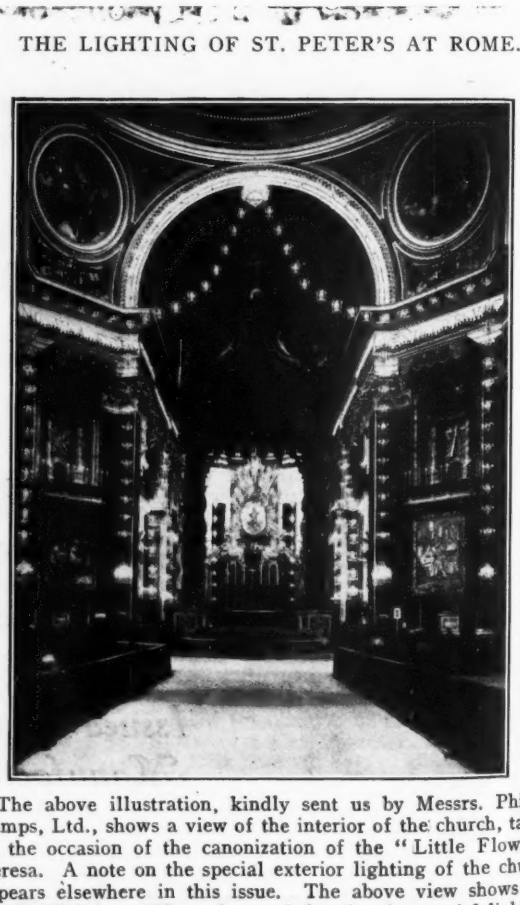
A recent issue of *A Thousand and One Uses for Gas* gives some interesting details of the use of gas for kinema theatres, special reference being made to the new "Capitol" Theatre, the lighting of which was recently described in this journal. This kinema theatre has seating accommodation for 2,000 people. The heating and ventilation is so designed that any desired temperature may be obtained. The whole heating and ventilating system is put into operation by turning on and lighting the gas in the tubular gas boiler, and starting the pumps and fans. It is stated that one consideration affecting the choice of this special system of temperature-control is the presence of an elaborate and costly organ, the condition of which would be liable to be affected by wide fluctuations in temperature. One other interesting statement is that, as the air is maintained at pressure slightly above atmospheric value, fog cannot enter this building.

Another model heating and ventilating system, at the Tolmers Cinema, Hampstead Road, is also described. This, too, is automatically controlled, first by a thermostat and also by an electrically operated valve.

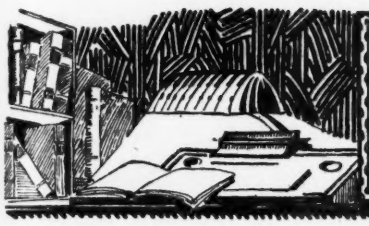
## SHADES, BOWLS AND REFLECTORS.

A recent Siemens' list illustrates modern shades, bowls and reflectors. This covers a wide range, and includes ornamental "Cornelian" glassware, one-piece unit globes having a clear neck and obscured lower area, silk shades and glass shades of the "pictorial" character. In an introduction some diagrams, illustrating the defects of unduly shallow and badly designed reflectors, are included.

## THE LIGHTING OF ST. PETER'S AT ROME.



The above illustration, kindly sent us by Messrs. Philips Lamps, Ltd., shows a view of the interior of the church, taken on the occasion of the canonization of the "Little Flower" Teresa. A note on the special exterior lighting of the church appears elsewhere in this issue. The above view shows the interior lighting. We understand that for the special lighting arrangements on this occasion no less than 13,500 Philips lamps were used.



# REVIEWS OF BOOKS AND PUBLICATIONS RECEIVED

THE PRODUCTION AND MEASUREMENT OF LOW PRESSURES, *by F. H. Newman, D.Sc., A.R.C.S., D.I.C., F.Inst.P. (Ernest Benn, Ltd.*, 1925, 192 *pp.*, 48 *figs.)*

Mr. Newman's book is an example of the present tendency towards specialization. As he remarks in the preface, high vacuum technique plays an important part in both physics and engineering; yet the available information is somewhat scattered and inaccessible. The subject is of primary importance in connection with electric lamp manufacture, but incidentally the study of high vacua has led to many important scientific discoveries and added much to our knowledge of electrons and ionic phenomena.

The introductory chapter contains a brief sketch of atomic structure and thermionic emission, after which methods of producing low pressures are discussed. We then pass to a general account of pumps, of which a variety, both of the mercury and oil type, are described in subsequent chapters. Elimination of residual gases plays a most important part in the making of electric incandescent lamps; the author regards mercury vapour diffusing pumps as the pumps of the future, but at present they require backing by some other form of pump, and, accordingly, the more familiar oil pumps are also described. Chemical and Electrochemical processes for cleaning up small traces of gas are also mentioned, and an account is given of special devices for measuring high pressures.

All these points are dealt with in considerable detail, and the book is illustrated by many tables and diagrams. Useful data are given in a series of appendices, and there is an adequate index. We commend the work to the attention of physicists and specialists in high vacua, and there is no doubt that it meets a distinct want.

A CATALOGUE OF BRITISH SCIENTIFIC AND TECHNICAL BOOKS.

We have received a notice of the above work, prepared by the British Science Guild and now entirely revised and enlarged. This is undoubtedly a useful production which fills a distinct want. The system of subdivision and indexing appears to be very complete, and the catalogue, containing about 500 pages, can be obtained from the British Science Guild (6, John Street, Adelphi, W.C.2) at a cost of 12s. 6d. net (postage 9d. extra).

FORTHCOMING CONGRESSES.

We have received particulars of the International Congress on Radiology, to be opened by H.R.H. the Duke of Connaught on July 1st. A preliminary reception will be held on the evening of June 30th at the House of the Royal Society of Medicine (Wimpole Street, London). The official Congress dinner is to be held at the Great Central Hotel on July 2nd, and a very comprehensive series of papers, showing clearly that Radiology has become an international subject, has been arranged. Meetings of the Congress are to be held in the Central Hall, Westminster.

The 36th Congress of the Royal Sanitary Institute will be held at Edinburgh during July 20th-25th. H.R.H. the Duke of York has accepted the honorary presidentship of the Congress, and the Right Hon. Sir John Gilmour, Bart., D.S.O., M.P., Secretary for Scotland, will deliver the inaugural address. Upwards of 1,200 members and delegates are expected to attend, and an attractive series of visits and discussions has been arranged. A Health Exhibition is to be held in connection with the Congress. Particulars may be obtained from the Secretary, Mr. E. White Wallis, 90, Buckingham Palace Road, London, S.W.1.

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